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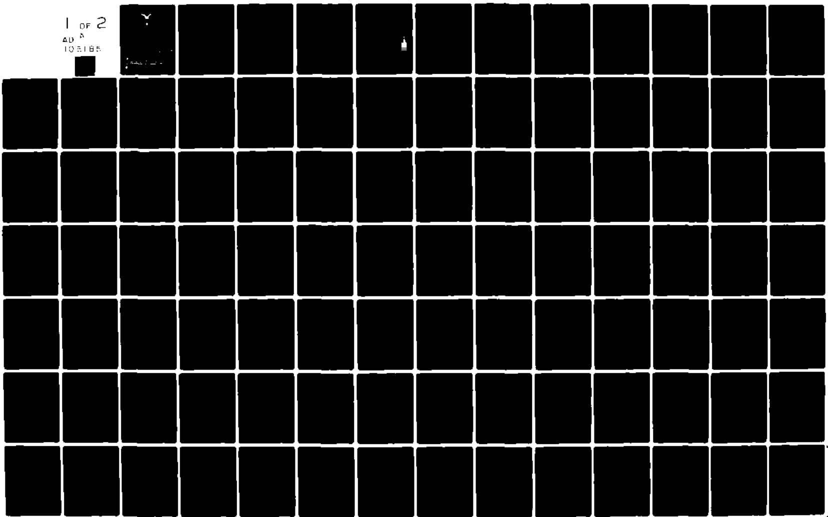

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A STUDY ON THE EFFECTS OF DIMINISHING MANUFACTURING SOURCES ON THE SUPPORTABILITY OF THE AN/ASQ-38 RADAR SYSTEM

David Capotosti, Captain, USAF
Eugene M. Curran, Captain, USAF

LSSR 24-81

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Logistics support costs for the B-52 weapon system have increased dramatically as a result of extending its useful life beyond that originally planned in its acquisition. The primary reason for this increased cost is the vertical unsupportability of many of its subsystems. One such system is the AN/ASQ-38 radar. The unsupportability of this avionics system has resulted from a phenomenon known as "diminishing manufacturing sources" (DMS). This phenomenon occurs when the number of contractors who manufacture the component parts of a particular system, such as the AN/ASQ-38, decreases (diminishes) as the system itself ages and becomes technologically obsolete. Thus, obtaining repair parts for such systems from an ever-diminishing source of supply becomes an ever more expensive proposition. This thesis studies the effects of DMS on the AN/ASQ-38 radar to determine the principle DMS factors contributing to the system's unsupportability. It extrapolates these factors to other DOD systems to determine those factors which drive the DMS problem in general. Methods are suggested that might be used to prevent or moderate the effects of DMS on the supportability of future systems.

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A STUDY ON THE EFFECTS OF DIMINISHING MANUFACTURING SOURCES ON THE SUPPORTABILITY OF THE AN/ASQ-38 RADAR SYSTEM

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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June 1981

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This thesis, written by

Captain David Capotosti

and

Captain Eugene M. Curran

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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COMMITTEE CHAIRMAN

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Chapter I

INTRODUCTION

OVERVIEW

Unsupportability of major aircraft systems presents a significant problem which Department of Defense (DOD) logistics managers must face and overcome. As these systems become older and their operational lives are extended, the DOD logistics community faces considerable difficulty in providing for their continued support. Often times, contractors who were providing the necessary replacement parts for these systems no longer find it economically feasible to do so. Consequently, logistics managers must now seek out alternative manufacturing sources if they hope to keep these systems fully operational.

The problem of unsupportability hinges on the concept of Diminishing Manufacturing Sources (DMS). A DMS situation occurs whenever

> the last manufacturing source ceases or intends to cease production of items needed in the DOD supply system. It also includes those cases in which the number of producers rapidly diminishes - thus increasing the likelihood that supply continuity will be interrupted [11:21].

DMS essentially is an economic problem that prevails in organizations which exhibit a high reliance on advanced

technology. These organizations very often fail to respond in a timely manner to the rapid technological developments taking place in industry.

The United States Air Force (USAF), as one such organization, finds itself particularly susceptible to the effects of DMS. The involved bureaucratic process required by various government regulations governing the acquisition of any major system often impinges greatly on the Air Force's ability to exploit technological change. Presently, the Major Weapon System Acquisition Process as defined in the Office of Management and Budget (OMB) Circular A-109, requires anywhere from eight to twelve years between initial concept of a system and its operational deployment. Because of the increasing rate at which technological change occurs, our systems can become technologically obsolete before they are operational.

Budgetary constraints imposed by the United States Congress serve to amplify the problems of DMS for the Air Force. Because financial resources available to the United States Government are finite, the Air Force must compete extensively with other Federal Agencies for its share of funds. Often, unless it can substantially validate a clear, operational need for an advanced technology, funds are not appropriated for new systems which exploit the new technology. Consequently, the Air Force must extend the operational lives of its present systems in order to

maintain combat readiness. The cancellation of the B-1 program by President Carter represents an ideal example of the case in point. Because of this decision the USAF had to extend the operational lives of its fleet of B-52 aircraft well into the 1990s. This represents an increase of ten to twenty years over what was initially planned when the B-52 was developed. This presented a real problem for Air Force logistics managers. Because of the rate at which technological change occurred over the past twenty years, they were unable to obtain the necessary replacement parts to support many of the B-52 systems.

The B-52 bombing/navigation system (AN/ASQ-38) represents one such system. Developed in 1960, it represents an example of a technologically obsolete system which had to be maintained because of the decision to cancel the B-1. In attempting to maintain this system, Air Force logistics managers found that due to effects of DMS, they could no longer provide the required support for the system. This has resulted in the development of a new Strategic Radar to provide the necessary supportability for the B-52 aircraft into the 1990s.

The purpose of this research effort is to evaluate the case of the AN/ASQ-38, and the specific DMS factors which contributed to its unsupportability. Hopefully, by studying the particular DMS case, knowledge can be obtained

which may be helpful in eliminating or minimizing the effects of DMS on future major aircraft systems.

BACKGROUND

Diminishing Manufacturing Sources is a problem that reflects the overall rapid change that has taken place in the electronics industry. Since World War II, the industry developed and produced improved versions of the vacuum tube (which had been introduced before the War), the transistor, and then the integrated circuit. While the change from vacuum tube technology to the transistor spanned a forty year period, the integrated circuit succeeded the transistor by only ten years (8:5, 11:21). By 1968, as industry was looking at widespread applications for the integrated circuit, they had already begun development of the microprocessor (11:22, 26:57).

The military's role as the leader in the consumption of mass-produced electronics was slipping. Industry was rapidly developing a consumer market in the private sector. From being the prime user of most of the electronics produced in the country twenty years ago, DOD procurement of new components had fallen off to ten percent of total market demand by 1978 (26:74). The military no longer controlled the electronics market. The rapid changes in technology that characterized the post-war industrial period had opened new markets for a growing industry.

These new markets proved to be considerably more responsive to changes in technology than the military market. As a study on DMS done by the Defense Electronics Supply Center (DESC) indicates, the DOD, because of the involved review process required by government regulations, is much slower than private industry in responding to new technologies. Because the Air Force, like other government agencies, cannot readily exploit these new technological concepts, the growth of aggregate demand [1] for this technology lags behind the demand for the same technology in the private sector.

The graph of a technological life cycle (Figure 1) illustrates this idea of the two different demand patterns for electronics in the private and public sector (11:79). By the time the Air Force fully develops its logistics plans that take the demand for new technologies into account, potential suppliers have already begun to phase these technologies out. Often they are developing some new technology to fill an anticipated need in the private sector. This disparity becomes apparent when one considers that, while it may require only nine to twelve months for civilian consumers to incorporate their demands for new

[1]For purposes of this discussion, aggregate demand refers to the total demand for a common-use electronics component by all military departments within DOD. It also includes requirements placed on the DOD logistics system by other agencies of the Federal Government.

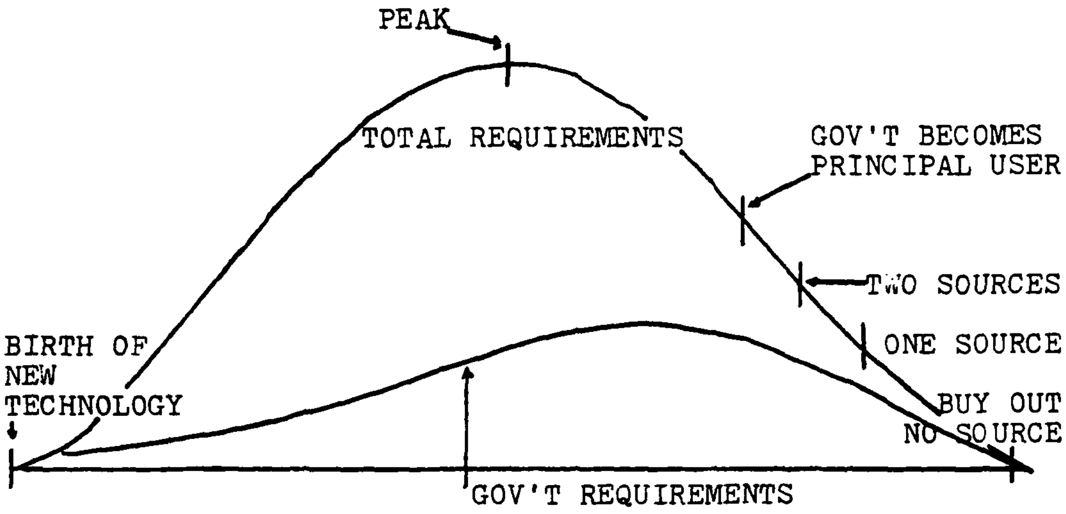

Figure 1. Life Cycle of Technology

components, the military may not develop a requirement for eight to twelve years. This is largely due to the lengthy reviews involved in the Major Weapon System Acquisition Process (Figure 2) (12, 15, 30, 31). This process does not adequately take into account the support requirements for the total life of the system. It does not realistically address continuation of the system in the active inventory beyond the initial deployment phase. The reliability studies which are conducted by the contractors cannot be verified by Air Force logistics managers until the system has been in operation long enough to develop a history of component failures. Consequently, specific replacement spares requirements cannot be accurately forecasted until this time (24). Because of this situation, contractors are very reluctant to commit their facilities to long range

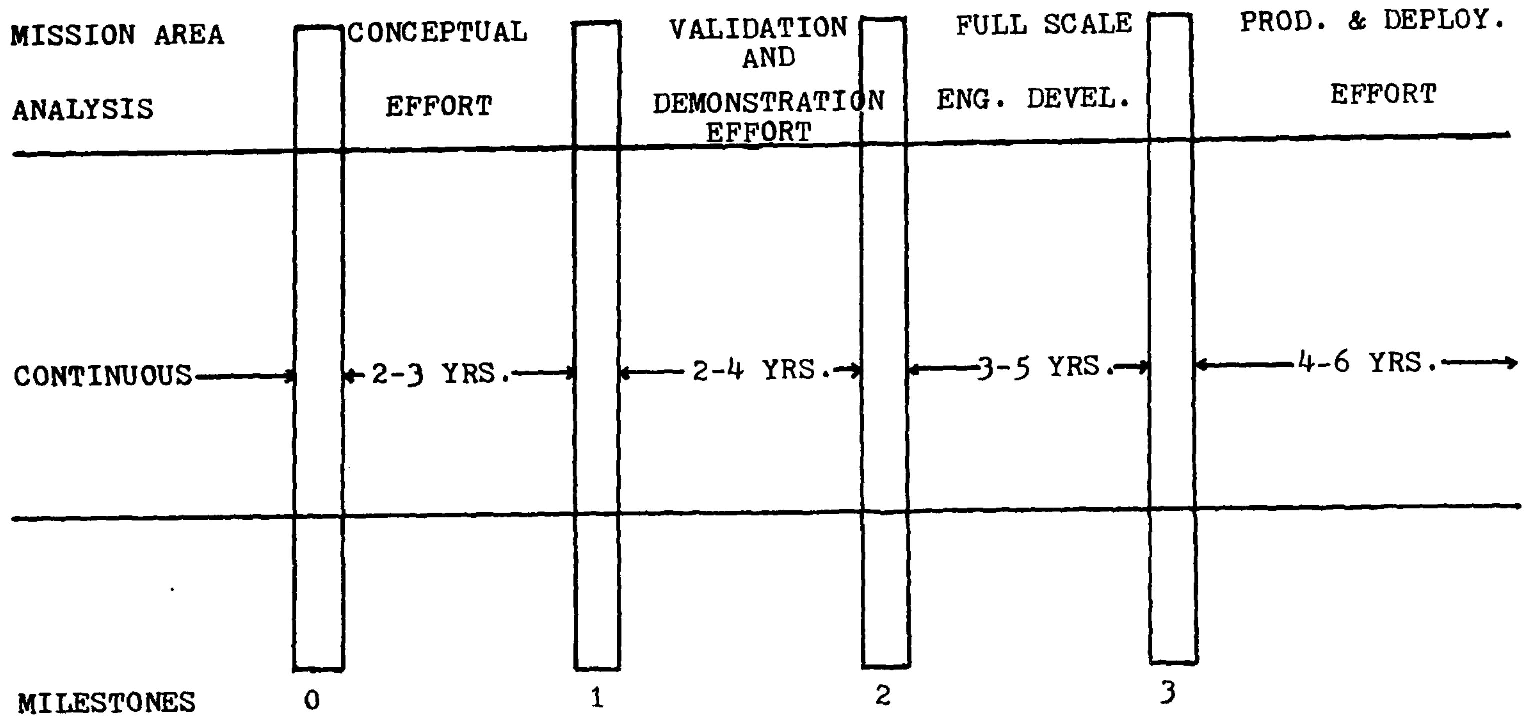

Figure 2. Major Weapon System Acquisition Process
(12, 15, 30, 31)

production (as long as twenty-five years for some components) of items which, in fact, may not be required by the Air Force (18). Because of this reluctance, the Air Force often times, finds itself in a situation of buying replacement parts ahead of time that may not be needed later.

Logistics managers will often receive a request for a component that is unavailable or in short supply. When this situation occurs, they will notify the item's manufacturer of the shortage, only to find that the item is no longer produced, or is in the process of being phased out by the vendor. The vendor will sometimes respond to the government demand for the component, but will negotiate an agreement with the government such that, once he fills the order, he will no longer produce the item. This situation is referred to as a "life-of-type-buy". In short, this situation involves a "one time procurement. . . for a quantity of an item no longer to be produced" (11:1-8). The decision on the amount to be procured is generally "based upon demand and/or engineering estimates of mortality, sufficient to support the applicable equipment until phase out of the system" (11:1-8). These estimates are not accurate in many cases due to the unforeseen extension of older major aircraft systems. Consequently, the components acquired may not be available beyond the date the planners used in projecting the spare parts requirements for the system. Once the available stock is depleted, logistics

managers must seek out a new source of supply for the non-available item. Usually, the cost associated with reacquiring a source of supply is extremely high because of the limited quantity purchased by the government and high production costs.

When a logistics manager arranges for a "life-of-type" buy, he will generally find that a vendor will produce all the government requires to maintain the system, and then discontinue the item. He may also find that the vendor is unwilling to commit his resources to the extent required to completely satisfy government demands. The logistics manager is then faced with a variant of the "life-of-type" buy. The "buy-out" is a situation that arises when a contractor will produce only what he deems economically feasible. The government will then only be able to satisfy part of its demand for the item. As in the more usual "life-of-type" buy, the logistics manager must then find another source when his stocks are depleted. The effects on costs are the same as the situation when the government tries to reacquire any phased-out component.

The DOD's problems with DMS will continue to worsen as "companies move on to broader, more profitable markets [35:68]." Technological life spans are continuing to shorten in response to innovation. The effect in the Air Force logistics system is potentially catastrophic in that major aircraft systems over time become less and less supportable.

Eventually, these systems must be phased out and replacement systems acquired.

One major aircraft system which had to be phased out because of unsupportability is the B-52's AN/ASQ-38 bombing/navigation system. Introduced in 1960, the AN/ASQ-38 incorporates vacuum tube technology. Due to technological advances in the electronics industry the system has become completely unsupportable. A new strategic radar, incorporating state of the art technology is being developed which will replace the AN/ASQ-38 by 1985. It is interesting to note that the Air Force and industry agree that the new strategic radar is being developed solely to update the system in terms of supportability, not because the new radar provides an increased mission capability (3, 6:55, 20).

Since the B-52 is the first in a long series of aircraft that will require modifications to remain abreast of the changes in the availability of electronics components, it would be useful to review what DMS factors actually led to the decision to replace the AN/ASQ-38. Since no clear perception of the DMS question exists within the DOD logistics community, valuable lessons may be learned that may eliminate or minimize the recurrence of DMS related problems in the future (11:87). There is inherent interest in the acquisition and logistics communities

concerning the whole issue of defining DMS in terms of specific effects on the supportability of major aircraft systems.

PROBLEM STATEMENT

The potential effects of DMS on the supportability of major aircraft systems are not clearly understood within the USAF. The AN/ASQ-38 radar system of the B-52 presents an excellent case for study of what can result from the lack of understanding of DMS. A definite need exists within the Air Force for better understanding in this area, especially at the program and system manager level. Methods need to be developed which, if considered during the acquisition phase of these systems, will eliminate or minimize the potential effects of DMS in the future.

RESEARCH OBJECTIVES

The objectives of this research effort are twofold. First, by isolating the specific DMS factors which contributed to the unsupportability of the AN/ASQ-38 radar system, we hope to provide a clearer understanding of the DMS phenomenon. Second, once the specific DMS factors relevant to the AN/ASQ-38 are isolated, our objective is to provide USAF logistics managers the capability to anticipate the potential effects of DMS on the supportability of future systems. Our intent in accomplishing this task is to

recommend certain methods which, if considered during the acquisition phase, could eliminate or minimize the effects of DMS for the Air Force in the future.

RESEARCH QUESTIONS

1. What are the specific DMS related factors which contributed to the Air Force's inability to provide the necessary support for the AN/ASQ-38 radar system?
2. What generalizations can be made concerning the applicability of the AN/ASQ-38 DMS factors to major aircraft systems of the future?
3. What methods can be developed which would aid logistics managers in eliminating or minimizing the effects of DMS?

Chapter II

RESEARCH METHODOLOGY

OVERVIEW

Chapter I provided a general background and justification for research on the subject of DMS and its impact on the supportability of major weapon systems. The research objectives were twofold: first to obtain a clearer understanding of the DMS phenomenon; and secondly, to develop methods for anticipating a potential DMS situation so its impact on future weapon systems can be minimized. The research questions indicated that the best approach for achieving these objectives was to collect the perceptions of those individuals knowledgeable on the subject of DMS.

As the background in Chapter I indicated, the majority of previous research efforts conducted on the topic of DMS have been done from the perspective of the Department of Defense. Realizing this fact, we felt that it would be interesting and informative if, in our study, the perceptions of the civilian industry concerning DMS were collected and analyzed. Therefore, using the AN/ASQ-38 radar system as the subject of our study, interviews were conducted with the system's prime and subcontractors. Additionally, interviews were conducted with other major

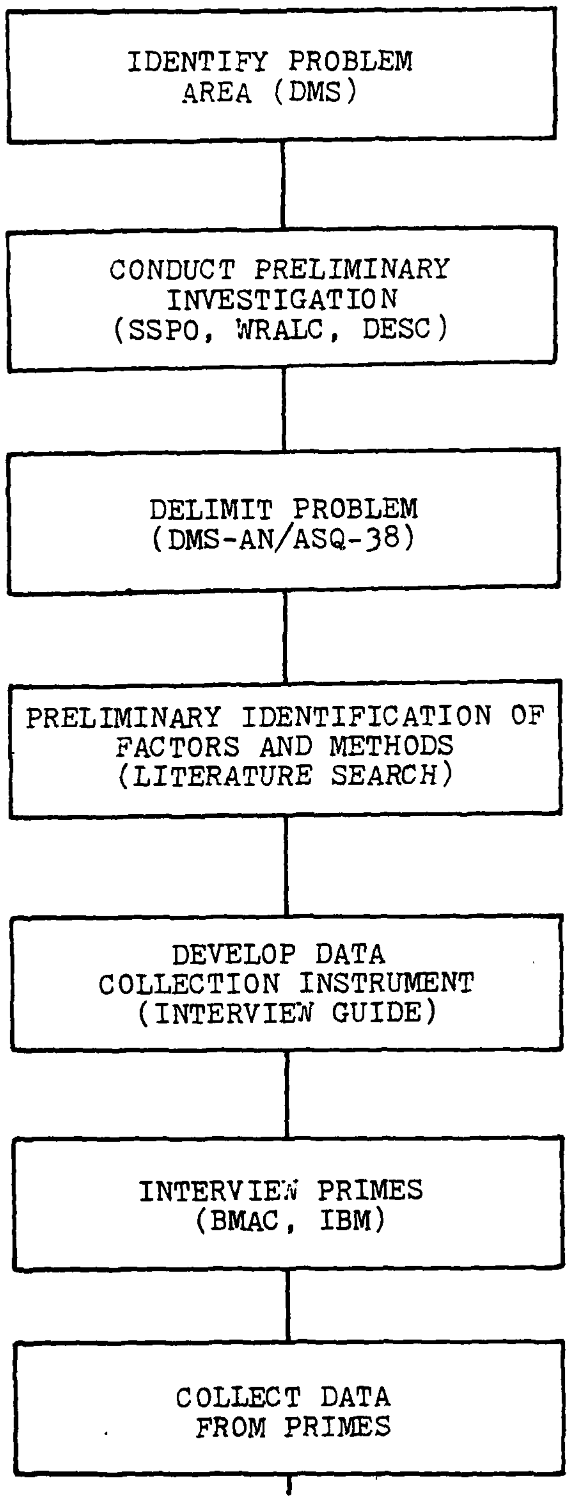

Figure 3. Flow of Research Process (p. 1 of 2)

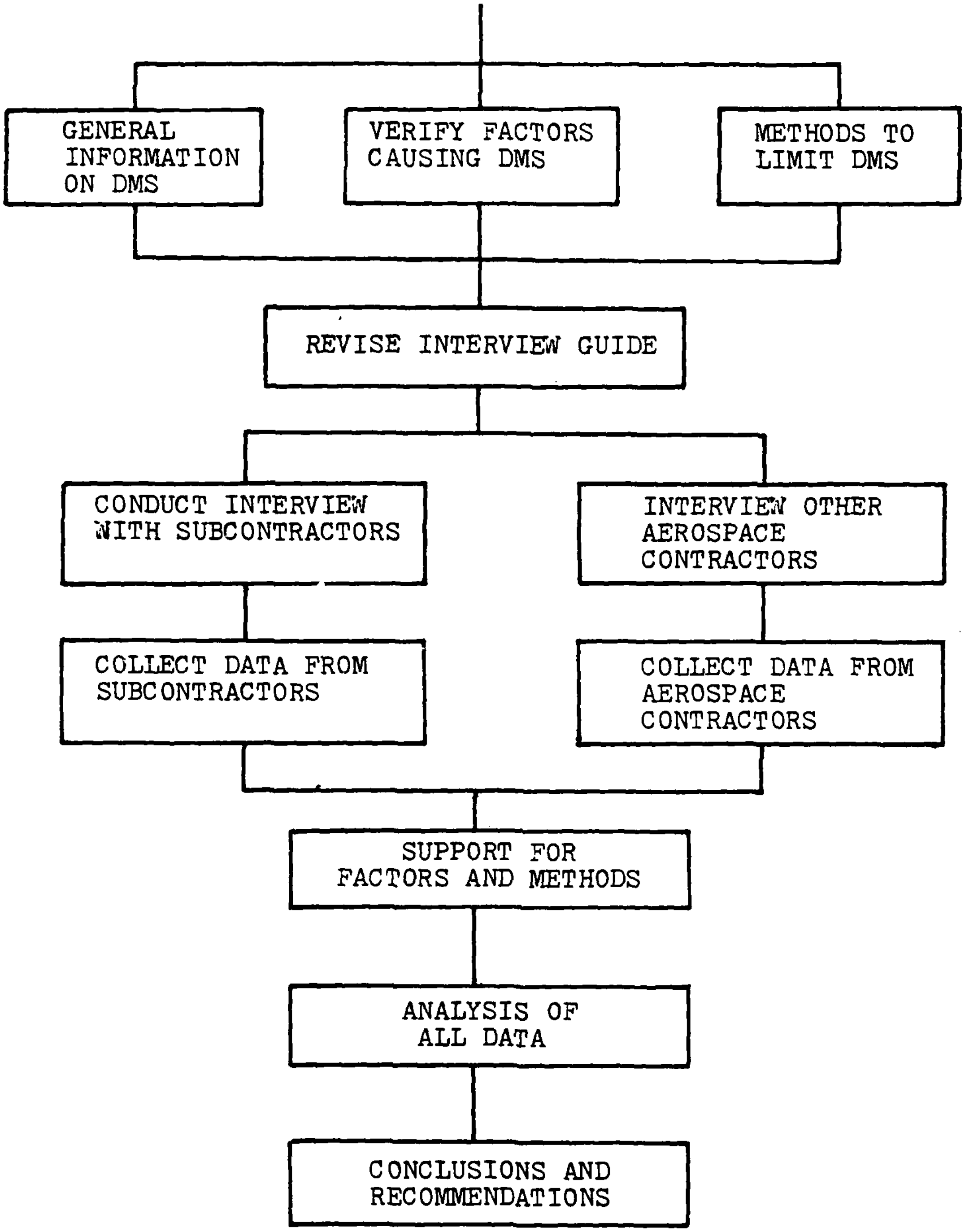

Figure 3. Flow of Research Process (p. 2 of 2)

aerospace contractors. The results of the interviews answered the research questions established in Chapter I, and answered the research objectives.

The entire research process which was followed throughout this case study analysis of the AN/ASQ-38 radar system is outlined in Figure 3.

RESEARCH DESIGN

The specific survey instrument used in this case study to collect data was the interview guide. The initial subjects of the interviews were the AN/ASQ-38 radar system prime and subcontractors. These are the individual firms who were responsible for the development of the system, and who are presently providing support. Conducting interviews with contractors at both levels was an essential element of the research design. Information from both sources was required in order to fully understand the impact of DMS on the supportability of this particular system.

In addition to interviewing the AN/ASQ-38 contractors, interviews were also conducted with other selected aerospace contractors. The purpose for doing this was twofold. First, conducting interviews with other contractors allowed us to validate the results which we obtained from the AN/ASQ-38 contractors. Secondly, the results from these interviews also provided information concerning other systems within the DOD inventory which are falling prey to

the DMS phenomenon. If what occurred in the case of the AN/ASQ-38 radar system can be linked with other DOD systems, then general applicability of the DMS phenomenon can be established.

The interview guide was structured so as to address the subject of DMS both in a general and specific nature. It contained questions on the subject of DMS and how it relates to the AN/ASQ-38 radar system. The questions addressed the issue of DMS in general and also the problems of DMS associated with the AN/ASQ-38 system. The questions were structured to follow an open-ended format. This approach was felt to be the best because it allowed the respondents to answer the questions with as much detail as possible, providing further insight into the DMS problem by use of examples and experiences.

The interview guide consisted of four sections, each addressing a particular aspect of DMS. The first section contained questions that delved into the general nature of DMS. The purpose of these questions was to obtain a comprehensive view of industry's concept of DMS and its effects on Air Force system effectiveness. The second section of the interview guide consisted of questions that looked at the DMS problem as it has affected the supportability of the AN/ASQ-38. Our intent here was to isolate specific DMS factors which had a direct effect on the ability of the Air Force to provide continued support for

the AN/ASQ-38. The third section of the interview guide dealt with the generalizability of the DMS phenomenon to other systems, both present and future. The purpose of these questions was to elicit responses from the interviewees identifying other systems with which they are familiar that have fallen prey to the same DMS-related problems as the AN/ASQ-38. If similarities and parallels among various systems can be identified, the generalizable conclusions concerning the effects of DMS on future major aircraft systems can be made.

While the first three sections of the interview guide contained questions which were generally descriptive in nature, the final section of the interview guide contained questions aimed at providing possible methods for dealing with DMS. The questions were structured so as to elicit suggestions and recommendations from the contractors on how to deal with DMS in the future. Additionally, in this section, we suggested possible methods we feel might be helpful in dealing with the problems of DMS and solicited the reaction of the contractors to these methods. Our purpose here was to record the reaction of the contractors to our suggestions, and gain insight into the pros and cons of these suggested methods for combating the effects of DMS. Utilizing the responses to these questions, in conjunction with our own analysis, we hope to make sound

recommendations for methods which can lessen the impact of DMS on the supportability of future aircraft systems.

DEVELOPMENT OF THE INTERVIEW GUIDE

The interview guide was developed using a two step process. The interview guide used in interviewing the AN/ASQ-38 prime contractors was developed by the authors based upon the information on DMS which was gathered during the literature search. After completing the interviews with the prime contractors and reviewing their responses, we reevaluated the interview guide for clarity, completeness, and validity. The prime contractors provided us with valuable information on DMS which we felt formed the basis for other questions that were included in the revised interview guide. Therefore, after interviewing the prime contractors, the interview guide was revised (see Appendix B).

Once the guide had been revised, interviews with the AN/ASQ-38 subcontractors and other major aerospace contractors were conducted. The data collected from all these interviews were analyzed and evaluated in Chapter III.

Chapter III

ANALYSIS OF RESULTS

OVERVIEW

This chapter presents the findings derived from an analysis of the contractor interviews. The framework for the analysis presented in the previous chapter is structured around the four individual sections of the interview guide. The first section deals with the contractors' views on the general nature of DMS. Section two highlights DMS factors leading to the unsupportability of the AN/ASQ-38 radar system. Section three addresses other DOD systems falling prey to the potential effects of DMS. This section discusses examples given by the AN/ASQ-38 contractors and other aerospace contractors and establishes a link to the general applicability of the DMS phenomenon. Section four discusses the contractors' suggestions on methods of dealing with DMS, highlighting those methods which contractors feel are needed in order for the DOD to ensure continued, long-range support for the military's weapon systems. The implications of these methods are also discussed.

GENERAL NATURE OF DMS

Discussions with the contractors indicated four aspects related to the general nature of the DMS problem: technological, functional, economical, and financial (5,11, 16,17,18). As the reader will recall, Chapter I discussed the technological and economical aspects based on what previous studies on DMS revealed. The contractors provided additional insight into these two areas and indicated a functional and financial aspect of the DMS phenomenon.

Based on the information from the contractors on DMS, we developed a conceptual framework from which to organize our discussion (see Figure 4). As the conceptualization shows, there are four areas which influence the DMS phenomenon: technological, functional, economical, and financial. Factors associated with each of these areas contribute directly to the problem of DMS. The link which translates DMS into unsupportability (the inability of the DOD to obtain replacement parts to keep a weapon system operational) stems from the exorbitant cost for items no longer commonly produced by industry. Related to and impacting on these exorbitant costs are the economic and financial policies under which the DOD must operate. When taken together, these different aspects and their associated factors ultimately drive the DMS phenomenon and the unsupportability problems faced by the DOD.

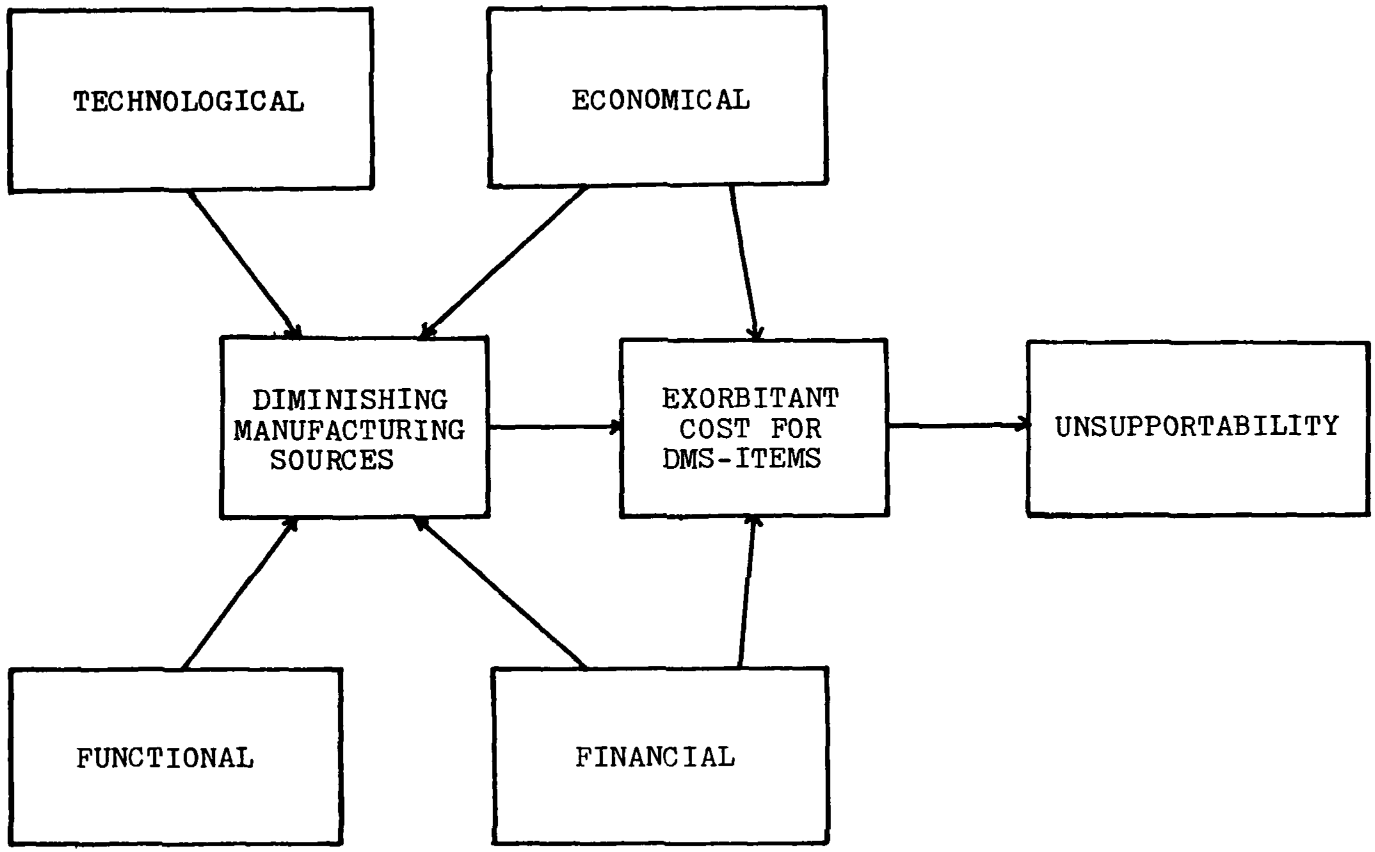

Figure 4. Conceptual Framework on General Nature of DMS

Before discussing individually the different aspects of our model, some elaboration on the link between DMS and unsupportability is worthy of discussion. All contractors interviewed agreed that unsupportability stems from the exorbitant cost required to produce DMS-items (items which are technologically obsolete and for which a source of supply is no longer available). They indicated that if sufficient funds are available, DMS and unsupportability are non-existent; industry will produce anything the DOD wants, provided the price is right (17,18). However, because the DOD must operate within the confines of a limited budget, it does not always have the resources available to pay the high cost for these DMS items and meet demand. Thus, it is from this situation that the backbone and link between DMS and unsupportability is established.

Technological

In addressing the technological aspect of the DMS problem, our discussions with the contractors centered on the concept of the technological life cycle. They indicated that the impact from this aspect of DMS stems from the lack of synchronization between civilian technological developments and their incorporation within the DOD (5,10, 17,18,25). Specifically, industry related two distinct and separate situations which leads to the disparity.

The contractors relate that the majority of the time the DOD lags behind the civilian sector in developing and acquiring systems based on new technologies (5,17,28, 24). The underlying factor which causes this situation results from the inflexibility in and the time required by the major weapon system acquisition process. As was pointed out in Chapter I, the acquisition process as described in OMB Circular A-109 can take up to twelve years from conceptualization to the actual deployment of a weapon system (12). Thus, when the DOD reaches its peak aggregate demand for a given technology, often times the civilian sector is in the process of phasing out this technology in lieu of a new, more advanced technology. Because of this, the DOD can experience difficulties in locating firms willing and capable of producing the items necessary to meet demand.

The inflexibility of the major weapon system acquisition process presents another problem in the area of the technological life cycle. Contractors felt that the DOD propogates the DMS problem to a large extent, because of the numerous regulations and restrictions associated with the acquisition process (5,17,18,25). They indicate that the structure of the process requires substantial commitment on the part of the DOD well before a technology has been thoroughly tested. These early commitments, which are required in the development of a system, along with the numerous restrictions inherent in the process often

handcuffs DOD planners. They are unable to capitalize on opportunities to incorporate the latest technological developments. Sometimes, as Fairchild, Singer/Kearfott, and Raytheon pointed out, DOD planners are forced to continue developing and producing items which may be technologically unsound (5,10,16,25).

The concept presented by these three contractors leads to the second situation affecting the technological aspect of DMS. In this case, instead of being too slow to incorporate a new technology, government moves too rapidly. Fairchild, Singer/Kearfott, and Raytheon indicated that the DOD will often seek to adapt an unproven (i.e., not thoroughly testec) technology into one of its weapon systems (5,16,25). In subsequent studies conducted by industry, very often the technology has been found to be unworkable. Realizing this, and that the technology is not commercially marketable, industry will discontinue its plans for exploiting the technology in favor of a more profitable endeavor.

The DOD, meanwhile, continues to move ahead with this unproven technology by incorporating it into its weapon systems. Because of previous contractual agreements, industry is committed to supporting the technology for the DOD. However, once the initial contractual obligations are met, industry will discontinue production of items based on this technology. Industry feels that it can ill afford to

keep costly production lines operating for items that are neither profitable nor commercially marketable. Consequently, when the DOD later places orders for these items, it finds that its original source of supply is no longer available. By definition, a DMS situation has occurred.

The contractors are in agreement regarding the impact of the technological aspect of the DMS phenomenon. There is a consensus among them that the DOD propogates the DMS problem because of the technological life cycle disparity which commonly exists (5,17,19,25). Whether the DOD moves too slowly or too rapidly in adopting a new technology is a moot point in the eyes of industry. The fact remains, the DOD no longer controls the electronics industry. Since 1960 its market share has dwindled to less than ten percent (26). Nowadays, government must compete equally with the private sector of the economy for scarcer industrial resources. It is the opinion of the contractors that the DOD must strive to improve its position within the electronics market. They indicate that a better synchronization of the technological life cycle disparity which exists between the two sectors is a step towards this goal.

Functional

Another aspect of DMS highlighted by the contractors addresses the functional aspect of the problem; that is, the ability of a particular component to accomplish

that activity for which it was designed. In viewing DMS from this perspective, the contractors discussed two areas of concern; the first deals with standardization and the second deals with rigid design specifications.

Standardization refers to a "component being uniform, conforming to specifications resulting from the same technical or functional requirements--capable of being used interchangeably [32:4-5]." DOD policy concerning the use of standardization during system acquisition is expressed in DODD 4120.3. It states specifically that program managers will incorporate standardization to the maximum extent possible during the acquisition of any system (28:1). Despite this explicitly stated policy, the contractors interviewed feel standardization is not employed to the maximum extent possible within the DOD. For example, design and development of the ground safety pin for the Navy F-18 cost the DOD $14,000. Yet there were 486 such pins listed in the Federal Catalog at the time, and the pin developed for the Air Force F-15 turned out to be interchangeable with that developed for the F-18 (1).

Failure to use standardization when it could be effectively employed results in the inefficient use of available resources. From a DMS perspective, it results in a variety of equipment types, each having its own individual demand requirements. To satisfy each individual demand requires contractors to operate numerous production

lines, which, in their opinion, is inefficient, unprofitable, and is not in a firm's best interest (2). Consequently, production lines are disassembled in favor of more profitable endeavors, and the government's source of supply for these items no longer exists. Once again, a DMS situation has occurred.

The second area impacting on the functional aspect of DMS deals with rigid DOD design specifications. DOD policy requires detailed specifications be explicitly delineated when issuing "invitations for bids" (IFB) in spares acquisitions (15,28). The contractors feel that such rigid specifications greatly hampers their flexibility in suggesting alternative components capable of accomplishing the same function (2,10,16,18). Often, these alternatives are designed based on improved technology and possess greater reliability than the original component requested. Yet, because they do not meet the specifications spelled out in the IFB, the DOD will not accept the alternative component. Contractors did indicate that they can submit engineering change proposals (ECP) for the replacement item. However, because extensive time is required for qualification and acceptance testing of the new component design, these ECP's may not be pursued by logistics managers when demand for the component is immediate (7,18,25). Thus, it is the contractors opinion that the inflexibility exhibited by the DOD in this area contributes to DMS.

Economical

The contractors identify an economic aspect to the DMS problem; specifically, the inflationary pressures of the US economy. They indicate that over the past decade, inflation has resulted in a near doubling in the cost of raw materials, skilled labor, and capital (5,9,16,19). It has eroded our industrial base and limited industry's productive capability, driving many once profitable firms out of the electronics industry completely. The ultimate result from such a condition is a vast reduction in the number of available sources which are capable of meeting DOD spares demand--a DMS situation.

For those firms capable of surviving the inflationary pressures, the impact is also felt. Contractors tell us that the high cost of capital needed for improving their productive capability is their greatest concern (5,10,16, 17,19). Frequently, investment funds are not available, and if they are, the interest rates are so high that firms are ultimately discouraged from borrowing (23:V-3). Thus, firms are forced to direct the production capability they do possess towards those activities which are most profitable--normally the civilian sector, because it controls a greater share of the electronics market than the DOD (26). Firms, in turn, discontinue operating those production activities which satisfy DOD demands, and consequently, the DMS problem surfaces once again.

Earlier in this chapter we developed the cost of a DMS-item as the primary link between DMS and unsupportability. From a DOD perspective, inflationary pressures contribute to system unsupportability through this link. The rising costs of raw materials, labor, and overhead have increased enormously the purchase price paid by the DOD for a given component. If the component is a DMS item, greater costs are incurred because of inefficient production techniques required to produce the item. As these costs skyrocket, the purchasing power of the DOD dollar diminishes, and there is a reduction in the quantity of components which can be purchased. Often this quantity is insufficient to meet demand, and thus, the system's effectiveness is degraded. Unsupportability problems arise and a major weapon system becomes non-operational.

As this discussion has indicated, economics does have a pronounced effect on the DMS phenomenon. From an industry viewpoint, inflationary pressures directly impact on a firm's productive capability and are related to the DMS problem. From a DOD perspective, inflation directly affects the cost of DMS items and impacts substantially on unsupportability.

Financial

The final aspect identified by the contractors as influencing the DMS problem is financial in nature. The

contractors indicated that they, like the DOD, must constantly operate within the confines of limited financial resources (5,9,10,25). Unlike the DOD, their primary motive for being in business is profit-oriented, and it is to this end that management directs its efforts. The stockholders, who own the enterprise, expect management to exploit those production activities that provide the best possible return on investment (ROI). Thus, in deciding which alternative to choose, management will choose that which provides a greater ROI. The contractors indicated that most of the time the financial opportunities available in the civilian sector are far greater than those available from the DOD. Therefore, there is no hesitation on their part to discontinue a DOD production activity in favor of one which provides a greater ROI. When this situation occurs, the DOD looses a valuable production source and a potential DMS situation exists.

The financial influence on DMS can be viewed from a DOD perspective also. In our conceptual model, it directly impacts DMS and influences cost as well. All of us are aware that the DOD must operate within the constraints of a limited budget. Never are congressional appropriations sufficient for the DOD to meet demand requirements within any fiscal year. Therefore, the DOD must take alternative choice decisions in an effort to get the most out of every dollar spent. Trade offs are required, which often result

in less than the required number of spares being purchased for a system. An additional impact is felt if the item is a DMS related one, because the exorbitant cost of this item will further restrict the quantity which can be purchased. Often, the DMS items are not funded because demand for the item was non-existant at the time the budget was submitted.

The financial impact on DMS is evident. In the case of industry, it stems from alternative choice decisions involving the firm's profit making motive and return on investment. In the case of the DOD, the limited DOD budget, when coupled with the high cost of DMS items can result in systems unsupportability.

In summary, this analysis has viewed the general nature of DMS from a systems perspective. Four different aspects of DMS problems were established. Their relationship to DMS was identified and analyzed. Table 1 is provided as summary of the different aspects associated with the general nature of DMS.

TABLE 1

SUMMARY OF ASPECTS ON GENERAL NATURE OF DMS

<u>Technological</u>

<u>Obsolescence</u> of item due to rapid technological change and long weapon acquisition process.

<u>Technologically Unsound</u> items due to pushing state-of-the-art technology.

<u>Functional</u>

<u>Standardization</u> of components lacking in systems acquisition.

<u>Rigid Design Specifications</u> limit procurement flexibility.

<u>Economical</u>

<u>Inflation</u> drives up cost of item and limits capital investment to expand productive capability.

<u>Diseconomies of Scale</u> due to small buys.

<u>Financial</u>

<u>Return on Investment</u> from DOD contracts not competitive with civilian sector.

<u>Limited DOD Funds</u> prevent the acquisition of sufficient spares.

DMS FACTORS AFFECTING THE AN/ASQ-38

The first section introduced the different aspects of DMS and our conceptualization of the DMS problem. This section discusses the specific DMS factors that contributed to the unsupportability of the AN/ASQ-38. Since these factors reflect the involvement of industry and the DOD in supporting the system, the discussion is organized in terms of industry-related, DOD-related and other DMS factors. The other factors are those external factors which cannot be affected by changes in industry or DOD policies, but do contribute to DMS in the case of the AN/ASQ-38.

Industry-Related DMS Problems

The AN/ASQ-38 was initially deployed in 1960. Since that time, other systems have been deployed that have placed a demand on the finite resources that are used to manufacture components for the AN/ASQ-38. Since these other production posibilities put these resources to better use, contractor support for the AN/ASQ-38 was discontinued so that the contractors could obtain a higher degree of resource utilization.

Because contractors do not have unlimited resources, they must decide what production strategies will make the best use of their available resources. Since building new facilities and buying new tooling is prohibitively expensive, one of the decisions that must be made is how to

use existing floorspace and tooling in a way that will maximize the contractor's return on the investment he made in the facilities and machines he currently uses. Ultimately, items that are no longer in high quantity demand must be discontinued by the firm to make room for the production of more profitable items. Consequently, the tooling used to make the unprofitable items is reassigned or is discarded, creating a lack of productive capability for items such as the ones that are a part of the AN/ASQ-38.

The decisions made by Boeing and IBM to phase out the tooling for the AN/ASQ-38 followed a decision-making process very similar to the one just discussed (10,18). Their decisions were based on a lack of demand for some electronic components, and the need for more floorspace by those managers responsible for producing other items. Since the items that were made using the discarded tooling were still in demand (but in much smaller numbers) IBM, for example, established a labor-intensive facility that could make components for the AN/ASQ-38 and other systems (18).

Another consideration that affected the decision to discard underutilized tooling was the lack of floorspace available to store all the unsold components that were coming off the production line. IBM's vendors felt that the lack of demand for the components did not justify maintaining large inventories. It would have been a waste of valuable floorspace, considering the annual demand on these

inventories was often projected by the DOD to be ten units or less for some items (18,25). So, small-quantity production using labor-intensive methods was preferable not only from a production viewpoint, but an inventory standpoint as well.

Boeing gave one example that illustrates the inefficiencies of producing items in small quantities. The Air Force determined it was necessary to replace some of the B-52's radomes after years of continual patching. Boeing, however, had long since discarded the castings and molds needed to make the radomes, because the Air Force did not project any requirement for additional spare radomes (10). Boeing had to retool to make them, which resulted in extremely high per unit costs to the government.

Very often, IBM could not find a vendor who would furnish them with the small numbers of items needed. The vendor was interested in producing only large quantities to take advantage of the economics of scale that come with large scale production runs. IBM encountered this situation when they finally located a vendor who could supply them with the type of acetate needed to make cursors for the scopes in the AN/ASQ-38 system. IBM had to purchase twenty sheets of the material, even though they needed only one sheet, because that was the smallest order the vendor would accept (19). We were told that IBM never charged the Air Force for the additional sheets, since an order

involving the purchase of additional materials was not considered by IBM as a cost it could justifiably pass on to the customer (18).

Clearly, the cost of producing components affected by DMS is an expensive proposition. This ultimately effects the price contractors charge the government which, in turn, decreases the number of components the DOD can purchase. In the case of the AN/ASQ-38, limits on available funds restricted the numbers of items bought on numerous occasions (18). When talking about DMS items, the contractors said that the following factors drove up the cost of producing replacement components for the AN/ASQ-38:

1. The cost of reengineering. Very often, the engineering drawings needed to make a component are unavailable. This occurs most often when a contractor must contract out to another vendor who is unfamiliar with the design of the item (18).
2. The cost of raw materials. Some components require the use of expensive materials that are tied to price increases in the open market. The gold needed in producing connecting cables for the AN/ASQ-38's subsystems is an example (18).
3. Start-up costs. These are non-recurring costs that drive up the cost of each unit produced, particularly if the start-up involves re-tooling and establishing a new production line (10).

4. Inspection costs. IBM routinely inspects every item it and its subcontractors produce (18). A lack of familiarity on the part of IBM's vendors in making DMS items makes this policy necessary. Without it, high rates of component failure could occur during operational use. This inspection policy, which is not required by the DOD, is seen by IBM management as a cheaper alternative to the costs of replacing the item if it fails.

Besides lack of productive capability, there are other DMS factors that affected the AN/ASQ-38. Contractors also have to deal with vendors who cannot, for one reason or another, provide timely support. One of the reasons, which we mentioned before, involves inventory considerations. Lack of demand often compels vendors to limit the number of different items they will stock. Another, more serious problem arises when a vendor that the contractor has ordered items from in the past goes out of business. When that occurs, delays result in filling an order because the contractor must find another source. This is a time-consuming process that often adds months to the lead time a contractor will quote the Air Force (10,18).

Vendors sometimes drop product lines after merging with other firms. If the vendor is absorbed by another firm, the new owners may decide to discard items that are not profitable. The contractor then must find another

source. If another vendor cannot be found who has the drawings and the necessary tooling, the contractor must produce the item himself. Since he must produce other limited quantity components, this places an additional labor-intensive production run on an already crowded production schedule.

IBM encounters this situation quite often with the AN/ASQ-38. The firm is concerned that its Owego, NY plant is becoming overwhelmed by small lot size production requirements (18,19). This trend is having a widespread impact on the operations of the Federal Systems Division. The more dissimilar items it must produce, the less familiar IBM's employees become with the items they manufacture. This causes higher component failure rates, and reduces productivity. IBM must also commit scarce resources to the production of these components, preventing them from using its resources in a more attractive venture (18,19).

IBM, therefore, has constructed a facility that is becoming more involved in "bits and pieces" production, involving labor intensive methods, and less involved in large scale manufacturing. The results of this trend for IBM are higher production costs, production inefficiencies, quality problems and longer lead times (18,19).

In summary, more attractive alternative uses for scarce resources contributed to industry-related DMS problems. The switch from older items produced for the DOD to

other military or even civilian component production resulted in a lack of productive capability necessary to manufacture components for the AN/ASQ-38. Because more time is being spent by contractors searching for qualified vendors, lead times have increased. When a vendor cannot be found, contractors manufacture items using their own resources, which results in production-related problems and higher costs.

DOD-Related DMS Factors

Boeing and IBM are convinced that the decision to phase-out the AN/ASQ-38 was as much due to the policies and procedures used by the DOD in processing spares as it was to the disparities in the technological life cycle. They maintain that the DOD does not project their procurement requirements for all common-use components, which results in the inefficient production runs and the high per unit costs discussed earlier (10,18,19).

The radome example provides one illustration of the type of short-sighted procurement that sometimes takes place. The Air Force, according to Boeing, did not realize that excessive wear and tear, as well as old age, would ultimately require that the radomes be replaced (10). Also, the Air Force could not consider a commitment to Boeing for the production of spare radomes because spares are not usually procured over a multi-year period. Since

the Air Force could not provide Boeing with information on the number of radomes it would need in the future, the castings and the molds were discarded.

This points out a major factor in the whole DMS problem. The DOD cannot take advantage of the economics of large scale production because spares requirements are not based on a multi-year period. This is not to say that the DOD is not aware of the advantages of multi-year planning. It is, by regulation, prevented from buying spares in anticipation of a long-range requirement for a certain item (27). Consequently, logistics managers will only consider their current spares requirements, and consider future requirements when the specific need for replacement items exists and the funds for them have been allocated through the planning, programming and budgeting system (27).

Since the DOD cannot consider future requirements until the funds are available, many contractors are very reluctant to invest in the manufacturing and warehouse facilities that are required by the DOD's long-range demand forecasts. They know that, come the next fiscal year, there may not be any need for the facilities and tooling they set aside. In other words, the funding may be cut off, leaving the contractors who made the investment without any way of recovering their investment from the government (5,10,18,25).

In the civilian sector, multi-year procurement (MYP) is a financial reality. With the commitment of the customer to a multi-year production program, and financial safeguards against cancellation by the customer, contractors are willing to set up the facilities to produce whatever items are needed by the customer. MYP is not widely used by the DOD, except for the acquisition of long-lead time items, such as the reengineering of the KC-135 tanker aircraft or the Air Launched Cruise Missile (23:VII-32). Briefly, MYP is a technique of acquiring systems whereby the DOD commits itself to the contractor for a multi-year period, without committing funds beyond the first year. If funds are not approved in subsequent years, a cancellation ceiling is established to repay the contractor for his unrecovered investment (27).

The contractors maintain that the procurement of spares on a year-to-year basis does not provide the vendor with incentives the way MYP does. So, the failure of the DOD to use multi-year spares procurement contributes to the disinterest in the electronics industry in pursuing DOD contracts. Boeing and IBM indicated MYP might have ensured sources for the components the Air Force needed to keep the AN/ASQ-38 operational if it had been used (10,18,19).

The extension of the AN/ASQ-38, according to Boeing and IBM, did jeopardize the continued supportability of the system (10,18). Both felt that keeping the system

operational may have worsened the DMS problem associated with it. Raytheon and Singer/Kearfott said that extending the system did not hamper supportability. Their differences in roles (contractor, subcontractor) probably made for the difference in the answers (5,25). Boeing and IBM are ultimately responsible for the system; contractually, they are bound to the support of the system throughout its life. The subcontractors are not bound to support the system for such a long span of time. Their responsibility is to support the AN/ASQ-38 for a short time; if they are faced with supportability problems they can adjust their commitments to support the system the next time their contracts with Boeing and IBM come up for renewal.

Another problem we discussed with the AN/ASQ-38 contractors was the rigidity of DOD specifications. The contractors indicated that the DOD is very reluctant to approve substitutions when the contractors cannot locate a source for the component that the DOD originally procured. Very often, the ECP submitted by the contractor is disapproved by the DOD because it does not conform to the original specifications. Boeing and IBM felt that this was true, but neither could site a specific example in the case of the AN/ASQ-38. Generally, the Air Force engineering review process at Warner-Robins Air Logistics Center (ALC) was considered quite good by IBM field representatives, who

indicated ECPs were approved in situations where the original item could not be produced (7).

In the case of the AN/ASQ-38, IBM gave us an example where the specification stipulated tolerances for a microdot connector that were unnecessary from an engineering standpoint. Since it was not known that the tolerances were unrealistic when the item manager and IBM went looking for a vendor, they received some negative responses from contractors before it was discovered that the tolerances could be changed without affecting system performance. Once the ECPs were approved, it was no problem finding a contractor (Ibid.).

IBM, as we said, could not think of a situation where stringent specifications could affect the DMS problem. They did say, however, that stringency can create delays in getting changes for an item approved because the more that is spelled out in terms of design in a specification, the more paperwork (i.e., ECP's) needed for each change in the design. This creates further delays in obtaining a DMS item (Ibid.).

In the case of the AN/ASQ-38, the contractors felt that the Air Force did not maintain an adequate record of component failures, which worked against realistic projections by DOD logistics managers of what was really needed in the DOD logistics system to keep the AN/ASQ-38 operational (5,10,18,29,25).

We contacted both Warner-Robins and Headquarters, Air Force Logistics Command to see what information they used to project component requirements. Boeing's and IBM's statements on lack of component failure history were true. In most cases, at Warner-Robins, component requirements were based on historical data, rather than a current picture of component failures and what was needed to replenish the inventory (7,14). We also asked Warner-Robins about the accuracy of Boeing's statement that arbitrary dates for discontinuing items in the inventory have been established within the DOD. We were told by the item manager for the AN/ASQ-38 that its components were coded in the ALC's computers in such a manner that they would not be eliminated automatically from Warner-Robins inventories. This was done in response to earlier difficulties in trying to keep the radar system's components in the inventory (22).

So far, we have discussed DOD budgetary considerations, the lack of a multi-year procurement policy for spares, stringent DOD specifications, the failure of the government to use a history of component failures and lack of long range forecasting as factors which affected the AN/ASQ-38. The current major weapon system acquisition process, the final factor in this section on government-related factors, was not implemented until OMB Circular A-109 came out in 1976 (34). So, the AN/ASQ-38 was not

acquired using this process. There is a feeling among the contractors, however, that in the case of other systems, the length of the major weapon system acquisition process is a contributing factor to DMS (5,10,18,19).

Other DMS Factors

This part of our discussion on DMS factors and the problems of supporting the AN/ASQ-38 addresses factors that are beyond the control of the contractors and the DOD. These factors also impact on the efforts of the AN/ASQ-38 contractors in meeting supportability requirements for the system. The DOD cannot acquire what it needs because it must deal with an external environment that is rapidly changing, leaving the DOD with a DMS problem that is rapidly making systems like the AN/ASQ-38 unsupportable.

The DOD is loosing its defense industrial base to the civilian sector because the DOD does not in some cases move rapidly to incorporate technological changes in component design. The civilian sector, meanwhile, has the capability to rapidly absorb changes in technology. From the standpoint of industry, the civilian sector represents a more profitable market for state-of-the-art products. Since producing the more profitable state-of-the-art components is a goal of most electronic firms, the industry is moving away from producing older defense-related items and toward the production of items for the civilian sector.

Since the resources available to meet these opportunities are scarce, technologically obsolete items, which are not as profitable as components which incorporate the latest developments, are being discontinued. Many of these items are part of DOD inventories.

The contractors told us the DMS problem they are encountering in supporting the AN/ASQ-38 is partly a result of rapid technological change occurring in the electronics industry (10,18,19). In the opinion of the AN/ASQ-38 contractors, the DMS problem associated with this system is in part due to the failure of the DOD to incorporate technological advances in some components that make up the system. Because the DOD continues to use technologically obsolete components, it is facing supportability problems in the case of older systems like the AN/ASQ-38. This is not the sole factor, however.

We also discussed the growth in the number of facilities that are using labor-intensive methods to make DMS items. This trend is also affected by the lack of skilled technicians familiar with the production of DMS-affected components. This factor is presenting severe problems for IBM in its efforts to keep the AN/ASQ-38 operational (18, 19). The lack of skilled labor involves longer lead times because individuals must become familiar with the sequence of steps necessary in making the components. It also means a potentially lower quality item coming off the production

line, which fosters delays, longer production runs and higher costs. Wages also continue to rise year after year, making labor-intensive production increasingly more expensive and less attractive to the firms who make DMS items. Ultimately, firms will discontinue production of DMS items and start producing products that give them a larger profit margin. It also allows them to remain competitive with other firms in the industry. This is an important factor in the case of the AN/ASQ-38, according to our interviewees.

One final point on external factors was brought out by IBM. Environmental and OSHA regulations can affect a DMS problem. For example, IBM had to locate cables for the AN/ASQ-38 that would comply with new Environmental Protection Agency guidelines on electro-magnetic interference (18). In addition, IBM has run into varying state laws on industrial safety. When it located its consolidated Federal Systems Division in upstate New York, it had to comply with different regulations than Alabama (a previous location) on the use of industrial lasers. The end result was that IBM had to purchase lasers that complied with New York's work safety laws, which represented a sizeable investment (19). These lasers were used in trimming and sealing power supplies used in the Automatic Offset Unit, a subsystem of the AN/ASQ-38.

The purpose of this section has been to outline the DMS factors behind the decision to phase out the AN/ASQ-38.

Table 2 lists all the factors we discussed. Our interviews with the contractors brought out the point that the severely limited use of MYP in the DOD may be as important as the technological life cycle concept in explaining the factors which affected DMS in this case. The section also discussed factors that imposed conditions on the DOD and industry. These factors, although outside the control of either government or industry, contributed to this DMS problem, and influenced contractors in deciding whether they should keep producing DMS items for the AN/ASQ-38, or produce items that can provide a better rate of return on investment.

TABLE 2

FACTORS THAT CONTRIBUTED TO DMS IN THE AN/ASQ-38

General Area	Industry-Related	DOD-Related	Other
Technological	Failure to maintain tooling	Extension of useful life of weapon system	Rapid pace of technological change
	Failure to maintain engineering drawings	DOD inventory policy on low demand items	Lack of skilled labor
Functional		Rigid design specifications	
Economical	Unwillingness to expand productive capability due to high cost of capital		Rapid growth of civilian electronics market
	Diseconomies of scale due to small lot sizes		
Financial	Return on investment disadvantage of DOD items	Failure to adequately forecast long-range requirements	Federal/state regulations (e.g., OSHA, EPA)
		Lack of multi-year procurement in spares acquisition	

GENERAL APPLICABILITY OF DMS

The previous sections discussed the general nature of the DMS problem, and isolated the specific DMS related factors which led to the unsupportability of the AN/ASQ-38 radar system. In this section, we address the applicability of the DMS phenomenon to other DOD systems. The section is structured in two parts. First, we highlight other systems currently within the DOD inventory which the contractors indicate are experiencing the same DMS problems as the AN/ASQ-38. Secondly, we verify those DMS factors isolated for the AN/ASQ-38 and discuss their applicability to other DOD systems.

Other Systems Experiencing DMS-Problems

Every contractor interviewed indicates that there are other DOD systems experiencing the same DMS problems as the AN/ASQ-38. Boeing points out that the B-52 Aircraft Modernization Program (AMP), currently in progress, not only calls for the replacement of the aircraft's bombing-navigation system, but other systems as well (3). For example, included in the AMP package are updates to the aircraft's environmental control system, autopilot, fuel quantity indicator system, and the AC and DC electrical power systems. The basis for these updates, Boeing states, stems from the same DMS related problems experienced in the AN/ASQ-38 (10). In fact, the groundwork for the entire AMP

program is based on a B-52 Reliability, Maintainability and Supportability (RM&S) Analysis Report conducted by Boeing. In this report Boeing identifies various B-52 systems which are presently unsupportable, or soon will be unsupportable because of DMS related problems (6).

Boeing also indicates that the Air Force is currently experiencing DMS problems in providing support for the nose radome of the B-52, and the environmental control system which cools the Short Range Attack Missile (SRAM) computer in the aircraft (10). They point out that in the case of the nose radome, the original castings and molds were destroyed, thus a retooling effort must be accomplished which will involve exorbitant costs and lead time. In the case of the environmental control system for the SRAM, Boeing relates they are having extreme difficulty in locating a vendor willing and capable of producing cooling fan blades for the system. The original producer of the fan blades is no longer in business (10).

IBM relates they also are experiencing similar DMS problems in their attempts to support other systems of the B-52 aircraft. An excellent example concerns the beta generator of the aircraft's Terrain Avoidance System. In a visit to their Federal Systems Division, IBM personnel stated that they had extreme difficulty locating a vendor willing to produce a resistor needed to operate the generator (18,19). Finally, after locating a vendor willing to

produce the item, twelve were ordered. When the resistors arrived, they were tested in a functional beta generator. All twelve of the items failed when tested. IBM indicated that their only option left is to redesign the resistor so the system would operate, then produce the item itself (18). This involves excessive lead times and the use of labor-intensive methods which are extremely costly.

Another system which IBM feels will fall prey to DMS is the AN/ASQ-48 radar system (18,19). The AN/ASQ-48 is a completely digital bombing-navigation system developed by IBM for the B-52D aircraft, which incorporates the latest state-of-the-art technology. The system is slated for operational use with the aircraft this year. The feeling at IBM is that in the near future this system will experience supportability problems because of the same DMS related factors which affected the AN/ASQ-38. IBM reached this conclusion because the results of an independent study they conducted indicate that many of the subcontractors who produced components of the system are no longer in business (19). Thus, they forsee problems in acquiring replacement spares for the system beyond the initial provisioning requirements.

Singer/Kearfott, McDonnell Douglas, Lockheed, and Fairchild all discussed systems which they build or support that are experiencing supportability problems related to DMS (2,5,16,17). For example, Lockheed is encountering

difficulty obtaining replacement parts for the C-5 landing gear and avionics equipment. Inadequate spares provisioning, tight funding, and inadequate sources of supply are the main causes for these supportability problems (2). Singer/Kearfott is experiencing similar difficulties in their efforts to support nine different versions of the doppler (a system which determines wind velocity and drift angle) for the C-130 aircraft. They indicate the main problems in this case are the lack of available vendors willing to produce replacement components for the systems, and their inability to place these components in the Air Force supply system. It is their belief that many of these doppler systems are indeed unsupportable because of DMS related factors (5).

Fairchild and McDonnell Douglas also talked about DOD systems which they manage that are encountering supportability problems because of DMS. These contractors expressed great concern with the automatic test equipment used in both the F-14 and F-15 fighter aircraft (16,17). Fairchild relates that it is also experiencing DMS related supportability problems with various systems (i.e., avionics) of the A-10 aircraft, and the Navy's Light Airborne Mobile Platform (helicopter). In all the above examples, the contractors indicate the problems stem from high failure rates, inadequate spares provisioning, and their

inability to locate qualified vendors capable of producing needed replacement components (2,5,16,17).

Many other examples of DMS-affected systems could be cited. However, the point is clear--DMS is not an isolated problem associated only with a particular DOD system or industry. It is a widespread problem potentially applicable to all types of components carried in the DOD logistics system. It can affect the smallest electrical component within a highly sophisticated subsystem as well as larger items which form the basic structure of an aircraft.

Verification of DMS Factors

Having established that DMS is indeed applicable to a variety of components within the DOD logistics system, we next direct our efforts to verification of the major factors which drive the DMS phenomenon, and hence, unsupportability. Using those factors isolated in the case of the AN/ASQ-38 as a basis for discussion, we queried contractors concerning the major factors they feel drive the DMS problem in general.

All contractors, with the exception of one, indicated that DMS is strictly a DOD-related problem. Singer/Kearfott, although agreeing that DMS is most prevalent in the DOD, indicated they have encountered similar DMS problems within the civilian sector of the economy (5). The primary reason contractors feel the problem is so widespread

within the DOD is the budgetary constraints under which it must operate. As discussed earlier, the DOD must operate under the constraint of limited resources. This limitation often results in inadequate spares provisioning, inability to procure spares in economic quantities, and an overall lack of incentive for firms to keep production lines operating. These situations, the contractors state, are not as common within the civilian sector of the economy (2,5,10,16,17,18,25). The extensive use of the single year procurement technique in spares acqusition (a budget-related issue) is another DMS factor for which there exists a consensus among the contractors. They point out that annual follow-on spares procurement handicaps the DOD's ability to effectively procure spare components, and thus, does not provide sufficient production continuity for firms within the industry. Consequently, many firms discontinue DOD production activities in favor of those activities which they feel provide greater long range benefits (2,5,10,16,17,18,25).

The technological life cycle dichotomy discussed earlier, which exists between the DOD and private sectors, is another major factor influencing the DMS phenomenon. Although two situations were discussed, the consensus is that the DOD is too slow to incorporate new technologies (2,5,10,16,17,18,25). Thus, when the DOD finally accepts the new technology, and attempts to obtain replacement

parts, they are unable to acquire them because industry has moved on to a new technology.

Inadequate long-range forecasting by the DOD is also a factor highlighted by the contractors as generally contributing to DMS. The DOD does not always indicate to the contractors what its actual long-range needs are (2, 5,10,16,17,18,25). Consequently, contractors cannot assure vendors that they will receive enough business to justify keeping costly production lines open. Therefore, vendors will direct their efforts to those customers (usually civilian) who are willing to guarantee stated long term needs. According to the contractors, this shift in emphasis from the DOD to the private sector is one reason for the rapid growth in the civilian side of the electronics market, and represents a reflection of industry's lack of confidence in the profitability and potential of the defense electronics market (2,5,10,16,17,18,25).

The contractors indicated a consensus concerning lack of productive capability within industry as a major factor impacting on DMS. Failure to maintain necessary tooling and engineering drawings, inflationary pressures, lack of skilled labor, and departure of firms from the industry are all contributing factors which impact on industry's productive capability. Although the contractors generally feel that the degree of productive capability within an industry is, to a large extent, a reflection of the

state of the economy, they nonetheless agree its impact on DMS and weapon systems' supportability can be dramatic.

DOD decisions to extend the useful lives of certain weapon systems beyond that originally planned is another factor that most contractors agree impacts on the DMS problem. Those contractors which act as primes for weapon systems feel the strongest about the impact of this factor (10,18,19). They point out that as prime contractors, they are committed to supporting a given weapon system as long as it is operational within the DOD inventory. Thus, their ability to provide replacement spares beyond the period originally projected is aggravated when weapon systems are operationally extended. Those contractors that traditionally perform roles as subcontractors (Singer/Kearfott, Raytheon) feel this factor is not as influential as it may appear (5,25). In further discussions on this issue they indicate they have no firm commitment to support these extended systems except when primes contract with them for isolated replacement spares. In effect, the decision to support the system is theirs, and is not influenced by the DOD's decision to extend a systems' useful life. Despite this feeling, the majority of contractors did indicate this factor is applicable to the DMS phenomenon.

The final factor which results indicate is central to the DMS problem is the structure of the present major weapon acquisition process. This factor was not

influential in the case of the AN/ASQ-38, because it was procured in early 1960 under a different DOD acquisition philosophy. However, all contractors agree, since its inception in early 1970, the current process has impacted significantly on the DMS problems encountered with other systems. The contractors feel that the excessive length of time required for the process tends to aggravate the technological disparity which exists between the civilian and government sectors of the economy (2,5,10,16,17,18). Thus, by the time a weapon system is deployed the number of available supply sources has diminished. Additionally, the advanced decision requirements inherent in the process, requiring substantial early commitment of resources, often prevents DOD planners from embracing alternative technological strategies that may be more advantageous from the perspective of supportability (2,5,10,16,17,18).

In summary, there is a consensus among the contractors we interviewed that there are indeed certain factors which tend to drive the DMS problem in general. They point out, however, that in any given DMS situation different factors, or combinations thereof, may predominate. Nonetheless, it is their feeling that any system which encounters supportability problems because of DMS will have its roots in the factors discussed above. Table 3 provides a summary of these general factors.

TABLE 3

SUMMARY OF GENERAL DMS FACTORS

Technological

1. Failure of industry to maintain tooling

2. Failure of industry to maintain engineering drawings

3. Extension of useful life of weapon system by DOD

4. Long weapon system acquisition process

5. DOD inventory policy on low demand items

6. Rapid pace of technological change

7. Lack of skilled labor in industry

Functional

1. DOD use of rigid design specifications

2. Failure of DOD to emphasize standardization

Economical

1. Unwillingness of industry to expand productive capability due to high cost of capital

2. Diseconomies of scale for industry due to small DOD lot sizes

3. Rapid growth of civilian electronics market

Financial

1. Return on investment disadvantage for industry on DOD items

2. Failure of DOD to adequately forecast long-range requirements

3. Lack of multi-year procurement in spares acquisition

4. Federal/state regulations (e.g., OSHA, EPA)

SUGGESTED METHODS FOR MODERATING DMS

In the previous section, we established the generalizability of the DMS problem. Indeed, it is a phenomenon not only affecting the AN/ASQ-38, but also other various systems within the DOD. Having established this fact, we next directed our attention to soliciting from the contractors recommendations for methods they feel may prevent or moderate the potential effects of DMS on system supportability in the future. As part of our discussion, we analyze each recommendation, highlighting where applicable, the important implications of each.

Improved Long-Range Forecasting

The contractors all agree an important step in solving the DMS problem is better use of long-range forecasting by the DOD (2,5,10,16,17,18,25). As was discussed earlier, "bits and pieces" is common in spares procurement. Not only does it prevent vendors from applying efficient production techniques, but it is also very costly to the DOD and results in excessive lead times. Firms are not motivated to produce in this haphazard manner, and so they will often times discontinue DOD production lines completely (2,5,10,16,17,18,25).

The contractors feel that the DOD needs to establish an improved long-range policy for spares acquisition. The DOD must indicate to the contractors that its need for

an item will extend for some period of time in the future. A commitment must be made to the contractor which will provide sufficient incentive for him to keep DOD production lines operating. Only if this can be accomplished can the DOD assure itself that sufficient sources of supply will be available throughout the operating life of a weapon system. Improved long-range forecasting is a step towards this goal. If properly used, it can be an effective method for moderating the potential effects of a DMS situation.

Multi-Year Procurement

A method which the contractors feel would have substantial impact on the DMS problem is increased use of multi-year procurement (MYP). As was pointed out earlier, this method of procurement in spares acquisition is prohibited by the Defense Acquisition Regulation (DAR). Logistics managers are forced to procure these items annually. The feeling in industry is that this lack of long-range commitment by the DOD makes the defense market unattractive (5,10,18,25). Consequently, firms tend to lean towards the civilian market where the use of MYP is used extensively and provides them long-range benefits.

One of the keys to combating the effects of DMS is for the DOD to improve its standing within industry. The use of MYP would be a step towards this objective. Firms who have supported various DOD programs based on multi-year

contracts have commented favorably on its use. They indicate MYP provides mutual benefits for both parties involved (9). From an industry perspective, MYP:

1. Allows for more efficient scheduling of production activities over the long run;
2. Provides a greater assurance of depreciation recovery on capital;
3. Provides a greater incentive to keep production lines operating because of long-range DOD commitments.

From a DOD viewpoint, multi-year procurement:

1. Generally provides better service from vendors because of the long-range commitment;
2. Results in non-recurring costs being distributed over a larger number of units;
3. Provides the opportunity for substantial cost savings as a result of the DOD's assurance of continuity of production over longer periods of time;
4. Would reduce production lead times by allowing contractors to accurately schedule and plan production activities.

The effective use of MYP involves the accurate forecast of long-range demands. This method of combating the DMS problem was previously discussed. It is important to realize that the use of MYP for spares acquisition is directly related to long-range requirements. The

contractors emphasize each method must be implemented in conjunction with other methods in order to effectively combat the potential DMS problem (5,10,18,25). Failure to do so will not significantly alter the DMS problem.

Standardization

The contractors stated that greater use of standardization during the acquisition of new systems is an excellent method for moderating the problem of DMS. As was discussed earlier, they felt the use of standardization within the DOD was not maximized, despite a directive encouraging its use. There are several advantages to the effective use of standardization, which the contractors highlight (5,10, 18,25). First, it would increase the DOD demand for a given component since a greater number of systems would use the item. Thus, industry would be given a greater incentive to keep production lines for the component operating. Secondly, since the DOD would require a greater number of components to satisfy requirements, it could purchase the components in more economical quantities at substantial cost savings. Finally, because the DOD must operate within the constraints of a fiscal budget, standardization would result in the more efficient use of limited resources.

The contractors did indicate that there are systems and components which are unique unto themselves, and that in these cases standardization is not possible.

Nonetheless, they do agree, that its use where applicable is unquestionably more efficient, and an excellent approach to reducing the possibility of DMS.

Greater Emphasis on Performance Specifications

Excessive emphasis on design specifications is a problem which contractors indicated contributes to the DMS problem. Often times they point out, a vendor may not be willing to produce a technologically obsolete item, yet he will produce a substitute based on state-of-the-art technology, which will perform the same function. The DOD however, will not go with the substitute because it does not fully conform to the original design specifications. More flexibility in this area, the contractors felt, would have avoided DMS problems in many cases.

Most contractors state that they would encourage greater emphasis by the DOD on performance rather than design specifications. Their feelings are based on the fact that this would provide them greater flexibility in their efforts to meet DOD requirements for spares that are technologically obsolete. They could provide substitute components which will adequately serve the function, and still remain within the original requirement. Most of the time the components possess greater reliability, and are less costly to produce than the original. The reason for this

stems from the high production cost that are incurred when producing items that are technologically obsolete.

Despite the benefits which can be derived from implementing the above policy, the contractors indicated there are several potential problems which can arise (5,10,18, 25). First, the potential for misunderstanding between contractor and the DOD is present whenever this degree of latitude on specifications is given in a contract. This type of contract can become a legal battleground where integrity and business ethics become points of litigation in a lawsuit brought against the contractor by the DOD. Secondly, as IBM noted, besides the legal implications that might arise from the lack of clarity in such a procedure, the DOD could find its operational readiness impaired because its demand for a needed component is not satisfied (18). If such a situation occurred, the results could be devastating.

Despite the inherent benefits and potential problems associated with greater emphasis on performance specifications, most contractors feel greater flexibility, especially when dealing with technologically obsolete items, would prove helpful in moderating the DMS problem.

Shorten Weapon System Acquisition Process

Currently, it takes the DOD eight to twelve years to bring a weapon system from the conceptual phase to

production and deployment. Meanwhile, technology is continuing to evolve. Because of the length of time required for the process to occur, these systems are often technologically obsolete before they are ever deployed, and the DOD's ability to obtain follow-on spares is greatly impaired.

The contractors feel the DOD should look at ways of shortening the weapon system acquisition process so that the technological disparity it produces can be minimized (5,10,16,17,18,25). It is their belief that if this can be accomplished, the potential for a DMS problem to occur can be greatly reduced. The DOD's objective must be to reduce the technological gap which exists between itself and the civilian sector of the economy. If this can be accomplished, it will ensure itself that a sufficient number of supply sources are available for replacement spares, and it will be able to provide support for a longer period of time.

One method for accomplishing this shortening of the acquisition process which we discussed with the contractors was the concept of concurrency. Concurrency is a weapon system acquisition policy in which various phases of the acquisition process occur simultaneously (15). The primary objective of concurrency is to shorten the time from the system's conceptualization to its actual operational deployment. The contractors were very positive on the

concurrency concept as a method of shortening the acquisition process. They felt it is a viable approach to minimizing the potential DMS problem.

There are potential pitfalls to the use of concurrency which Boeing, McDonnell Douglas, and Lockheed felt were worthy of mention (2,10,17). First, these contractors indicated that it is not applicable to all weapon system acquisitions. The use of concurrency on any given project requires thorough analysis and evaluation by all involved. Secondly, and probably most importantly, if concurrency is not implemented properly it can result in excessive cost overruns which will affect both the government and contractors involved. The key to success lies in a properly managed program by both government and industry. If this can occur, the acquisition process will be shortened, and the potential devastating effects of DMS will be curtailed.

Increased Responsiveness to Technological Change

A concensus among contractors exists concerning the lack of DOD responsiveness to technological change and developments within industry, particularly in the electronics industry. Many feel that failure of the DOD to react on a timely basis in this area creates the DMS problem. Contractors often suggest technologically improved, more reliable components for spares replacement, but the

contractor-submitted ECPs are disapproved (7). The reason given most frequently is lack of funds.

In a discussion with IBM personnel at their Federal Systems Division, they related the results of a study they conducted for the Navy in which they evaluated the long-range cost benefits of incorporating technological change in various systems. The results showed that in the majority of cases, responding to technological change provided greater savings to the government over the long-run than trying to support an obsolete technology (18).

The contractors realize it is not feasible, both from a practical and financial aspect, for the DOD to incorporate every new technology that hits the market, nor would they recommend this policy. However, they do feel that in certain situations, the potential benefits in terms of cost, warrant serious consideration.

Increased DOD-Industry Communications on DMS

Contractors feel there exists a lack of full understanding on the nature and impact of DMS on the part of industry and DOD. This lack of understanding contributes to and aggravates the DMS problem. Industry, although aware of DMS, must be more attuned to the needs of the DOD when a DMS situation occurs. The DOD, on the other hand, must realize that the DMS problem exists and is very real. To amplify this point, Boeing relates an incident which

occurred in 1979. In an effort to get a handle on the B-52 DMS issue, the Strategic Systems Program Office (SSPO) held a conference which included contractors, item managers for the B-52, and SSPO personnel. The objective was to obtain information on those components for which item managers were experiencing difficulties locating a production source (10). Only one item manager responded with a list of components for which he felt that DMS was a problem. The other item managers would not even acknowledge the existence of DMS, let alone that they were experiencing DMS-related problems in their efforts to obtain spares. Boeing indicates this position on DMS is not realistic, for as prime contractor for the B-52, they are intimately aware of numerous systems which are experiencing DMS problems (10).

The contractors wholeheartedly agree that the DOD must first fully acknowledge the existence of DMS (10,19). Once this is accomplished, then more information flow between the DOD and industry on the subject is required. DMS is a joint DOD-industry problem. It requires a cooperative effort to fully understand the phenomenon and moderate its effects on future DOD systems.

In summary, contractors feel these methods, if implemented, would reduce the potential effects of DMS. Although each method was addressed separately in our discussion, contractors indicate they are interrelated. By

incorporating all these methods, the DOD can lessen the DMS phenomenon, and provide the necessary support to keep its weapon systems operational. Table 4 is provided as a summary of the contractor suggested methods for dealing with DMS.

TABLE 4

CONTRACTOR SUGGESTED METHODS FOR MODERATING DMS

1. Improved DOD long-range forecasting
2. Increased use of multi-year procurement techniques in spares acquisition
3. Increased use of standardization in acquisition of systems
4. Greater emphasis on performance specifications
5. Shortened weapon system acquisition process
6. Increased DOD responsiveness to technological change
7. Increased DOD-industry communications on subject of DMS

Chapter IV

CONCLUSIONS AND RECOMMENDATIONS

OVERVIEW

This chapter draws together the results of our analysis discussed in Chapter III and shows how the objectives of our research were accomplished. The first objective was to obtain a clearer understanding of the DMS phenomenon by isolating those specific DMS factors which contributed to the unsupportability of the AN/ASQ-38 radar system. This was accomplished by conducting interviews with those contractors involved in the support of this specific system. After isolating the DMS factors related to the AN/ASQ-38, we established their applicability to other systems within the DOD. The second objective of our research was to determine those methods which might be employed by the DOD that would eliminate or minimize the DMS problem. We accomplished this by soliciting recommendations from the contractors we interviewed, and then analyzing these recommendations in terms of their implications.

This chapter discusses the applicability and appropriateness of the methods suggested by the contractors from the DOD's point-of-view. First, we offer our conclusions on the DMS problem based upon the information collected

throughout this research effort. Secondly, we recommend which methods of limiting the potential effects of DMS, discussed in Chapter III, are feasible and desirable from the perspective of the DOD. Included with our recommendations are suggestions on how these methods should be implemented.

CONCLUSIONS

The DMS problem covers a wide-range of issues relating to technology, function, economics and finance. In our earlier discussion on the general nature of DMS, we referred to these issues as the aspects of DMS. We also identified industry-related, DOD-related and other factors which contributed to the unsupportability of the AN/ASQ-38 system.

The General Nature of DMS

There are four aspects of DMS: technological, functional, economic and financial. These aspects were not only present in the case of the AN/ASQ-38; they were present in the case of other systems. It is important to realize that DMS is not only a problem at the component level. The four aspects of DMS apply also to major systems, and due to a cumulative effect, can ultimately make an entire weapon system unsupportable. The unsupportability of the

B-52 is an example of this cumulative effect on a weapon system.

Contributing Factors to DMS

The problems experienced in the case of the AN/ASQ-38 can be found in other weapon systems as well. The same general factors which relate to the AN/ASQ-38 contribute to a fuller understanding of the DMS phenomenon. Table 3 on page 60 summarizes these contributing factors.

Methods of Lessening the Impact of DMS

Since DMS is applicable to other systems, it is important to review possible methods for lessening or possibly eliminating DMS. Table 4 on page 71 lists the methods that were discussed by the contractors. In our opinion, these methods are basically sound. It is important, however, to realize that these methods are interrelated. For example, if MYP is to be implemented, long range demand forecasting is necessary in order to determine the numbers to be purchased during each year. The remainder of our conclusions deal with these and other methods.

Multi-Year Procurement. Multi-year procurement (MYP) is one method that can be employed to lessen the effects of DMS. To effectively use MYP, however, would require changes to the Defense Acquisition Regulation (DAR). In addition, to effectively use MYP there must be:

1) an accurate and usable data base that would be helpful in long-range forecasting,

2) and a system for identifying potential DMS items long before the items become unsupportable.

Each of these methods, including changes to the DAR, will be discussed. Although each of these methods can be implemented separately, they should be implemented as a whole in order to increase the effectiveness of MYP.

To implement effective multi-year procurement programs for acquiring spares would require changes to the DAR. The sole use of firm-fixed prices in MYP is one clause in the DAR that would have to be amended.

The effectiveness of MYP is based on a stable economic environment, free of high rates of inflation, because the cost of items is fixed throughout the time the items are being produced. The DAR currently states that MYP cannot be used unless a firm fixed price is established. So, given current provisions in the DAR and the high rate of inflation in the economy, MYP is not possible unless the contractor is willing to accept a firm fixed price throughout the duration of the contract. This may not represent an attractive alternative to some other opportunity that may give a greater return on the contractor's investment. The DOD should, therefore, create a more favorable economic and financial environment that would make the production of spares for the DOD more attractive.

Secondly, the DAR only considers competitive bidding when it addresses MYP. It does not consider sole source selection. Since DMS assumes a lack of qualified contractors, MYP may not be feasible unless sole source guidelines can be established for use in acquiring DMS items. These guidelines are necessary in order to make MYP a feasible procurement technique.

Thirdly, the DAR and other legislation limits the government's liability in the event of contract cancellation to $5,000,000. This ceiling has been established to reimburse contractors for non-recurring costs incurred due to a DOD contract. A concensus on the part of contractors and the DOD indicates that the current ceiling may not be enough to ensure contractor interest in spares production. So, the DAR may have to be changed and new legislation passed to ensure contractor participation.

Lastly, the DAR places limitations on the DOD when it comes to buying in anticipation. Since the DOD is often put in a position of accepting or rejecting a life of type buy, the DOD should be allowed to procure spares in advance of actual, specific requirements. This is necessary in order for the DOD to exploit potential cost savings, or to take advantage of one last opportunity to procure what it may need to keep a system operational.

<u>Long Range Demand Forecasting</u>. In order for item managers to determine when spares should be procured, they

must have an accurate and usable data base. Historical data on DMS items usage is not enough to ensure accuracy, however. The data base should consist of a history of component failures for DMS items. Such a data base would provide an up-to-date source for projecting long-range demand and might also serve as a way of identifying future DMS items. In both cases, a history of component failures represents a source of information that should provide a basis for procurement decisions.

Once the data base has been established, item managers need to consolidate their requirements over a multiyear period. To do this requires forecasting long-range demand for a particular item. There are advantages to doing this. Long-range demand forecasting constitutes an input to production decisions; it allows contractors to schedule their production without having to set-up and initiate production more than one time. In conjunction with MYP, it can reduce per unit cost since it allows contractors to take advantage of the economics of large scale production. It also serves as a basis for funding, allowing the DOD to set the precise cost of maintaining a spares inventory for a particular system.

Increased DOD-Industry Communications on Potential DMS Items. Long-range forecasting may not identify potential DMS items. To do so requires communication between the DOD and industry. This is necessary in order for the

DOD to decide when procurement actions for a DMS item should be implemented. Communication between the DOD and industry would, therefore, serve as an early-warning system for components that are potential DMS items. In addition, more communication on DMS could provide the basis for a joint DOD-industry information system that would identify long-range DMS problems. Adequate communication is needed to identify components before they become DMS items. The DOD and industry are not currently as much involved in predicting DMS as they are involved in the resolution of existing DMS problems. So, any MYP program should involve greater dialogue on the effects of changes in technology on weapon system supportability. One of the advantages of long-range identification of potential DMS items would be that it would lessen the possibility of a system becoming totally unsupportable. It would also facilitate long-range demand forecasting.

So far, we have discussed methods that relate to the effective implementation of an MYP program. There are also other methods that may lessen the impact of DMS.

Increased Use of Standardization. Increased use of standardization is another method that the DOD can use to combat DMS. It would be advantageous to the DOD because it would decrease the number of different components in the inventory. Standardization would enhance the desirability of producing replacement items because, with standardization,

the quantities produced would be larger, and per unit non-recurring costs would be lower.

Use of Performance Specifications. Using performance specifications for DMS items is another possible way of lessening the DMS problem. Performance specifications allow greater flexibility for logistics managers and contractors who are attempting to find a qualified substitute for an unavailable item. Chapter III discussed the dangers of using performance specifications. It is important for logistics managers to realize that performance specifications should be employed only when they can contribute to resolution of a DMS problem. Performance specifications are useful from the perspective of standardization. Very often, contractors will attempt to seek out a qualified substitute, rather than make an entirely new component. So, performance specifications can facilitate standardization not only within the DOD, but between the DOD and the civilian sector.

Increased Responsiveness to Technological Change. Increased responsiveness to technological change would enhance the DOD's ability to cope with DMS. However, there are many factors affecting the feasibility of technological changeover. We feel the most important thing to consider is the budgetary process. The DOD employs such a large variety of technologies in its systems that in any one year the DOD cannot budget for adequate spares for each of

them--the budget constraints just do not allow for it. Secondly, the cost of deploying systems is so high that to move in motion with the civilian sector could result in a waste of resources. The DOD would not obtain the fullest utilization of these systems before they are phased out. Thirdly, the disparity in the technological life cycle and the lead time required to get a system from concept to deployment is directly affected by a step-by-step process in systems acquisition. Earlier decisions affect later decisions, and so on. To continually adopt the latest breakthroughs would require constant reevaluation of program objectives and system design, increasing costs and delaying system deployment.

Shortening the Acquisition Process. Shortening the length of the major weapon systems acquisition process is one possibility for alleviating potential DMS problems later on. A concurrency concept may be an answer to the problem. Another answer may be that in the acquisition process the DOD address integrated logistics requirements more, including DMS as one of the concerns in providing support for new systems. We feel long-range demand forecasting, MYP, more flexible specifications and increased standardization can all play a part in developing logistics support for electronic components. DMS is a real problem that can effect new systems soon after they are deployed.

It would be to the DOD's advantage to consider DMS as early as possible in the acquisition process.

RECOMMENDATIONS

Based on our analysis of the suggested methods for moderating the DMS problem, we feel the DOD should consider implementation of the following methods in its efforts to address the DMS issue.

Multi-Year Procurement

We recommend multi-year procurement (MYP) as a method of alleviating or lessening DMS. Presently, the Defense Acquisition Regulation does not include spares in the list of items that can be acquired using MYP. This restriction should be lifted, and MYP procedures should be incorporated in the DAR that would take spares procurement into account. To make MYP a viable procurement technique, the DAR should be amended, to include the following:

1) Under existing regulations governing the use of MYP, firm fixed price contracts are required. No contract provisions for inflation are allowed. We recommend that the DAR be amended, allowing escalation clauses to be included in contracts where they would serve as incentives to the contractors and where they would be in the interest of the DOD.

2) We recommend that sole source guidelines be established. This will allow the use of MYP in cases where only one contractor is available to produce a DMS item.

3) The cancellation ceiling should be changed. Currently, the government's maximum liability to the contractor is $5,000,000. Considering the sizeable investment the contractors must make in tooling and production, this ceiling is not realistic. Studies should be undertaken to determine an appropriate cancellation ceiling. Implementation of the findings would involve changes to the 1979 Appropriations Act, which set the $5,000,000 ceiling.

4) We recommend an easing of the restrictions on buying in anticipation. The DAR presently restricts the acquisition of items because of lower prices and production opportunities. In the case of spares this is clearly not in the DOD's best interest because it prevents the DOD from taking advantage of life of type buys and other contractor-proposed solutions to a potential DMS situation. We recommend that the DAR should be amended, and a clause inserted which would allow the DOD to buy spares in anticipation of some future need, even though that need may not be clearly defined.

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In order to facilitate MYP, we recommend that:

1) an accurate and usable component failure data base be constructed;
2) a system for forecasting long-range demand be established;
3) a system for identifying potential DMS items be established.

We will now elaborate on these recommendations.

Long-Range Forecasting System

For some time, AFLC has been using historical data to determine order levels for common-use electronic components. This data is based on average usage rates, rather than actual, recent failure rates. With systems becoming older, failure rates increase. So, the use of historical data can result in lower demand forecasts for these items than what is actually required. We recommend that an information system be developed that would consolidate component failure data and organize it in a manner useful to item managers. This system would allow item managers to better project long-range DMS item requirements.

Increased DOD-Industry Communications on Potential DMS Items

We recommedn that:

1) The DOD conduct an in-depth study to determine the long-range impact of rapid technological change on the supportability of DOD systems. To do this, the

DOD should establish some mechanism with industry to determine the future trends in the electronics industry, to include the changes that might affect the viability of logistics support for technologically obsolete systems.

2) The DOD and the electronics industry should establish working groups and conduct DMS symposia as a preliminary step toward resolving the DMS issue. The purpose would be to establish better DOD-industry communication on DMS. Another purpose would be to establish an early-warning system that would identify specific systems tht might become unsupportable before they adversely impact on DOD readiness.

3) The DOD and industry should establish a standard system for alerting the DOD logistics and civilian electronics communities of a potential DMS situation . We recommend that AFR 80-10 be amended to include specific DMS procedures on the use of the Government Industry Data Exchange Program (GIDEP). The idea behind using GIDEP for the purpose of identifying DMS items is to find or develop sources who are willing to produce DMS items.

We also recommend the use of other methods to lessen the effects of DMS that are not related to MYP.

Increased Use of Standardization

The increased use of standardization is necessary to ensure that the DOD has the necessary components to support current and future requirements. Despite the existence of DODD 4020.3 which encourages the use of standardization, we feel the area requires increased emphasis. We recommend that the Army, Navy and Air Force should increase their dependency on common-use items. In addition, we recommend that the services identify off-the-shelf, commercially available items and incorporate them in existing and proposed systems as much as possible. At the same time, the services must ensure adequate performance for each system by not taking standardization to such an extreme where it degrades the mission effectiveness of each system that employs standardized components.

Use of Performance Specifications

We recommend that performance specifications be implemented for DMS items only, whenever they may alleviate a DMS problem. We caution that performance specifications are not long-range substitutes for proper design. Design specifications should be employed to the maximum extent possible to insure the most desired design characteristics and to alleviate the legal and performance problems we discussed in Chapter III.

Increased Responsiveness to Technological Change

The costs associated with keeping the DOD in line with the changes in technology are extremely high. To keep the DOD logistics system technologically current would also require a very rapid turnover of inventories. From a logistics viewpoint, it would make the logistics picture a great deal more complex then it is already, and would introduce new management problems and production inefficiencies. Therefore, we do not recommend that the DOD blindly respond to technological change. Earlier, we discussed a management system that would identify trends in electronic technology. We recommend that this same management system be used as part of a technology assessment program. The purpose of this program would be to assess if a technological breakthrough requires a change in componentry. Using information obtained from the contractors on the costs of continuing the production of specific technologically obsolete components, the DOD would conduct cost/benefit analyses and life cycle cost studies of both the old component and its state-of-the-art replacement to determine which is more economically advantageous. Using industry responses to DOD inquiries on supportability as a supporting factor, we recommend that these analyses be used as a basis for determining which systems require upgrading, and which systems can remain in operation without modification. Performing these analyses would allow the DOD to selectively

advance with the state-of-the-art technology and at the same time obtain the greatest possible use from systems that are currently in the inventory.

Shorten the Acquisition Process

The major weapon system acquisition process has been cited as a contributing factor to DMS. Specifically, it has been singled out as a cause of the dichotomy in technological life cycles. Since greater syncronization of the military and civilian technological life cycles is necessary to lessen the future effects of DMS, we recommend that ways be considered to speed up the acquisition process. One of the ways this can be done is through the use of schedule concurrency. This is essentially an acquisition process where development and production overlap, rather than the current practice where production follows development. In essence, schedule concurrency reduces the time spent in validating the results of system testing. The system is put into production before all the design specifics are worked out. The idea is to reduce the time it takes to field a new system, thus enhancing the technological viability of the system. To do this, system development is hurried along and production start-up is initiated while the design of the system is being finalized. Once this is done, a production contract can be awarded. The use of schedule concurrency can reduce time to

deployment of a system 20-25 percent. In spite of the cost risks that schedule concurrency can entail, we recommend that the DOD move ahead with its plans to use schedule concurrency.

More consideration of standardization, and earlier consideration of the effects of DMS on supportability in the major weapon system acquisition process can reduce the impact of DMS in subsequent years. One way to do this is to require DMS consideration by contractors who submit responses to DOD requests for proposals. Another way is to periodically check during the acquisition process for actual or potential DMS problems. Some changes to the acquisition process could require revisions to DOD directives, Office of Management and Budget guidelines and Air Force and major command regulations. Other changes would be up to the discretion of the program amanger. We therefore recommend that the DOD consider DMS early in the acquisition process, and study methods to incorporate DMS considerations in program management directives, guidelines and regulations, where applicable.

Recommendations for Further Research

Based on the conclusions and recommendations reached in this research effort, we recommend the following areas for further research:

1. a study be conducted to determine appropriate escalation clauses for inclusion in multi-year procurement contracts;
2. a study be conducted to determine a more realistic and appropraite cancellation ceiling for use in multi-year procurement;
3. a study be conducted to determine methods that can be used in the tracking of component failures;
4. The DOD conduct life cycle cost studies to determine when it would be advantageous to discontinue production of DMS items and develop a productive capability based on a new technology.

In summary, this chapter provided the conclusions and recommendations to our case study of the effects of DMS on supportability. The conclusions section addressed the interrelatedness of the aspects and factors which contribute to DMS. It analyzed the methods addressed in the previous chapter, emphasizing the feasibility of these methods from the DOD's point-of-view. The section on recommendations indicated the importance of systematically dealing with DMS, using MYP, long-range forecasting, standardization, and other methods. It addressed changes in the major weapon system acquisition process that would help lessen the occurrence of DMS in future systems. The chapter concludes with recommendations for further research.

APPENDICES

APPENDIX A

DEFINITIONS

DEFINITIONS

1. <u>Concurrency</u> - a weapon systems acquisition policy in which various phases of the acquisition process are overlapped and occur simultaneously. The objective of this policy is to shorten the time from conceptualization to operational deployment of the system.

2. <u>Diminishing Manufacturing Sources (DMS)</u> - A situation in which the last manufacturing source ceases or intends to cease production of tiems needed in the DOD supply system. It also includes those cases in which the number of producers rapidly diminishes - thus increasing the likelihood that supply continuity will be interrupted (11:21).

3. <u>Life of Type Buy</u> - A one time procurement, when all other alternatives have been exhausted for a quantity of an item no longer to be produced. Procurement quantity will be based upon demand and/or engineering estimates of mortality, sufficient to support the applicable equipment until phased out of the system (29:1).

4. <u>Long-Range Demand Forecasting</u> - production planning which considers demand requirements of a needed item over the entire life cycle of the item.

5. Maintainability - A characteristic of design and installation which is expressed as the probability that an item will be restored to specified conditions within a given period of time when maintenance action is performed in accordance with prescribed procedures and resources (33:44).

6. Major Weapon System Acquisition Policy - That policy described in Office of Management and Budget (OMB) Circular A-109, dated April 1976 which pertains to the acquisition of major systems by all executive agencies (30,31).

7. Multi-Year Procurement - Purchasing by a single contract of more than one year's requirements but with annual funding, and with the commitment to reimburse contractor for his unrecovered start-up costs in the event of contract cancellation after the first year (9:35).

8. Productive Capability - The necessary manufacturing resources (labor, financial, managerial, technological, engineering) required to produce a specific item for a customer at any point in time.

9. Reliability - The probability that a system, subsystem, or equipment will perform a required function under specified conditions, without failure, for a specified period of time (33:73).

10. Standardization - The property of being uniform; conforming to specifications resulting from the same technical or functional requirements--capable of being used interchangeably (30:4-5).

11. Supportability - The capability of a logistics system to acquire the necessary items to sustain and maintain a weapon system in an operational configuration. It is a measure of the effectiveness of a logistics system which includes the determination of spares requirements, the acquisition of the required spares, distribution of the items to the operational users, and the proper maintenance of those items.

12. System Effectiveness - The probability that a system or product can successfully meet an overall operational demand within a given time when operated under specified conditions, or the capability of a system to do the job for which it was intended. System effectiveness relates to the ability of a system to fulfill a defined need and is a function of performance, capacity, availability, readiness, reliability, maintainability, supportability, dependability, etc (4:238).

13. Technological Change - The evolution that occurs within a specific industry from an existing technology to a newer more advanced technology incorporating the latest state of the art developments in that particular industry.

14. <u>Technological Life Cycle</u> - The total life span of a technology beginning with its conceptual formulation and extending through its operational use and removal from industry as the primary method of production.

APPENDIX B

INTERVIEW GUIDE

INTERVIEW GUIDE

I. General Nature of DMS

1. Are you familiar with the concept of Diminishing Manufacturing Sources (DMS)?

2. The Defense Electronics Supply Center (DESC) defines DMS as a situation in which the last manufacturing source ceases or intends to cease production of items needed in the DOD supply system. Their definition also includes those cases in which the number of producers rapidly diminishes thus increasing the likelihood that supply continuity will be interrupted. Do you feel that this is an adequate operational definition of DMS?

3. Are there other situations which can occur that are significant enough to be included in this definition of DMS? If so, what are they?

4. Our research indicates that there is an economic and technological aspect to the DMS problem. Are there any other aspects besides the economic and technological which you feel might impact on DMS? If so, what are they and would you elaborate on them?

5. Many individuals from government and industry with whom we have discussed the DMS problem indicate it is becoming an increasing problem with the DOD. Would you comment on this statement?

6. Is the DMS problem within the DOD largely due to its inability to incorporate new technologies on a timely basis? If so, what factors place the DOD in this technologically inferior position?

7. Do you feel the DMS problem impacts on the DOD's ability to effectively carry out its mission? If so, in what way does this occur?

8. Having established that DMS is a problem within the DOD, are you encountering the same problem with your civilian customers? If so, could you cite some examples?

II. Specific DMS Factors

1. For AN/ASQ-38 Prime and Subcontractors Which of the factors listed below do you feel contributed to the DMS problems encountered in the case of the AN/ASQ-38 radar system?

2. For Other Aerospace Contractors Which of the factors listed below do you feel contribute to the problem of DMS?

   A. Lack of productive capability in industry

   B. Failure of industry to maintain necessary tooling.

C. Failure of industry to maintain necessary engineering drawings.

D. The opportunities for greater return on investment from the civilian market.

E. Extensive time required for major weapon acquisition process to occur

F. Lack of adequate long-range forecasting within the DOD

G. DOD decisions to extend the useful lines of weapon systems beyond that originally planned

H. Limited DOD budget, and the lack of multi-year procurement for spares acquisition

I. Rigid DOD design specifications for components

J. Rapid pace of technological change

K. Increase in alternative civilian applications of electronics technology

L. Decrease in the availability of skilled labor

M. Restrictions from federal regulations and varying state safety work laws

3. <u>For All Contractors</u> Are there factors not mentioned above which you feel are related to the DMS problem and therefore should be included above? If so, what are they?

III. General Applicability of Factors

1. For Other Aerospace Contractors Could you cite some specific examples of systems that your firm supports for the DOD which have fallen prey to DMS and are experiencing supportability problems? Are the DMS factors discussed previously primarily responsible for this condition?

2. For AN/ASQ-38 Contractors Are the specific DMS factors discussed in the case of the AN/ASQ-38 applicable to other DOD systems which you manage? If so, could you cite some specific examples?

IV. Suggested Methods for Minimizing DMS

1. Which of the following methods listed below do you feel would be helpful in eliminating or minimizing DMS?

   A. Improved DOD long-range forecasting.

   B. Increased use of multi-year procurement for spares acquisition within the DOD.

   C. Increased use of standardization during weapon system's development and acquisition.

   D. Greater emphasis by DOD on performance specifications rather than design specifications thus allowing contractors more flexibility in suggesting substitute components.

   E. Shortened Major Weapon System Acquisition Process.

F. Increased responsiveness by the DOD to technological change.

G. Increased DOD-industry communications on the subject of DMS.

2. Are there any other methods not discussed above which you feel might be helpful in eliminating or minimizing the DMS problem? If so, what are they?

APPENDIX C

SUMMARY OF CONTRACTORS'RESPONSES ON DMS FACTORS

SUMMARY OF CONTRACTORS' RESPONSES ON DMS FACTORS

	Boeing	IBM	Raytheon	Singer/ Kearfott	McDonnell Douglas	Lockheed	Fairchild
I Industry-Related							
1. Lack of Productive Capability	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Failure to Maintain Necessary Tooling	Yes	Yes	Yes	No	Yes	No	Yes
3. Failure to Maintain Necessary Engineering Drawings	Yes	Yes	No	No	No	Yes	No
4. Greater Investment Opportunities in Civilian Market	Yes	Yes	Yes	Yes	Yes	Yes	Yes
II DOD-Related							
1. Extensive Time Required in Systems Acquisition Process	Yes	Yes	---	Yes	Yes	Yes	Yes
2. Lack of Long-Range Forecasting	Yes	Yes	Yes	Yes	Yes	Yes	Yes

	Boeing	IBM	Raytheon	Singer/ Kearfott	McDonnell Douglas	Lockheed	Fairchild
3. Extension of Weapon System Useful Lives	Yes	Yes	No	No	Yes	Yes	Yes
4. DOD Budget Limitations and Lack of Multi-Year Procurement in Spares Acquisition	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Rigid DOD Component Design Specifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes
III Other							
1. Rapid Pace of Technological Change	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Unavailability of Skilled Labor	Yes	Yes	Yes	Yes	Yes	No	Yes
3. Excessive State and Federal Regulations	No	Yes	No	No	No	No	No
4. Increase Applications of Electronics Technology in Civilian Economy	Yes	Yes	Yes	Yes	Yes	Yes	Yes

APPENDIX D

SUMMARY OF CONTRACTORS' RESPONSES ON

METHODS FOR MODERATING

DMS PROBLEM

SUMMARY OF CONTRACTORS' RESPONSES ON METHODS FOR

MODERATING DMS PROBLEM

	Boeing	IBM	Raytheon	Singer/ Kearfott	McDonnell Douglas	Lockheed	Fairchild
1. Increased use of Standardization	Yes	Yes	---	Yes	No	Yes	Yes
2. More Emphasis on Performance Specifications	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Shorter Weapon System Acquisition Process (i.e., concurrency)	Yes	Yes	---	Yes	Yes	Yes	Yes
4. Increased Use of Multi-Year Procurement	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Improve Long-Range Forecasting	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Increased DOD Responsiveness to Technological Change	Yes	Yes	Yes	Yes	Yes	---	Yes
7. Increased DOD-Industry Communications on Subject of DMS	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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